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<b>(21) International Application Number:</b> PCT/US97/12035 <b>(22) International Filing Date:</b> 17 July 1997 (17.07.97)  <b>(30) Priority Data:</b> 60/022,125              18 July 1996 (18.07.96)              US 08/838,682              9 April 1997 (09.04.97)              US  <b>(71) Applicant:</b> CORNELL RESEARCH FOUNDATION, INC. [US/US]; Suite 105, 20 Thornwood Drive, Ithaca, NY 14850 (US).  <b>(72) Inventor:</b> BANDER, Neil, H.; 2 Hemlock Hills, Chappaqua, NY 10514 (US).  <b>(74) Agents:</b> GOLDMAN, Michael, L. et al.; Nixon, Hargrave, Devans & Doyle LLP, Clinton Square, P.O. Box 1051, Rochester, NY 14603 (US).		<b>(81) Designated States:</b> AL, AM, AT, AU, AZ, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).  <b>Published</b> <i>With international search report.          Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>
<b>(54) Title:</b> TREATMENT AND DIAGNOSIS OF CANCER  <b>(57) Abstract</b> <p>The present invention is directed to the use of antibodies or binding portions thereof, probes, ligands, or other biological agents which either recognize an extracellular domain of prostate specific membrane antigen or bind to and are internalized with prostate specific membrane antigen. These biological agents can be labeled and used for detection of cancerous tissues, particularly cancerous tissues proximate to or containing vascular endothelial cells, which express an extracellular domain of prostate specific membrane antigen. The labeled biological agents can also be used to detect normal, benign hyperplastic, and cancerous prostate epithelial cells or portions thereof. They also can be used alone or bound to a substance effective to ablate or kill such cells as a therapy for prostate or other cancers. Also disclosed are four hybridoma cell lines, each of which produces a monoclonal antibody recognizing extracellular domains of prostate specific membrane antigens of normal, benign hyperplastic, and cancerous prostate epithelial cells or portions thereof.</p>		

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## TREATMENT AND DIAGNOSIS OF CANCER

The present application claims the benefit of U.S. Provisional Patent Application 60/022,125, filed July 18, 1996, and is a continuation-in-part of U.S. Patent Application Serial No. 08/838,682, filed April 9, 1997, which claims the benefit of U.S. Provisional Patent Application Serial No. 60/016,976, filed May 6, 1996.

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### FIELD OF THE INVENTION

The present invention relates to the treatment and diagnosis of cancer with biological agents.

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### BACKGROUND OF THE INVENTION

In spite of improved treatments for certain forms of cancer, it is still a leading cause of death in the United States. Since the chance for complete remission of cancer is, in most cases, greatly enhanced by early diagnosis, it is very desirable that physicians be able to detect cancers before a substantial tumor develops. However, the development of methods that permit rapid and accurate detection of many forms of cancers continues to challenge the medical community. One such illustrative form of cancer is prostate cancer.

Prostate cancer is the most common cancer in men with an estimated 317,000 cases in 1996 in the United States. It is the second leading cause of death among men who die from neoplasia with an estimated 40,000 deaths per year. Prompt detection and treatment is needed to limit mortality caused by prostate cancer.

### Detection of Prostate Cancer

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When it metastasizes, prostatic cancer has a distinct predilection for bone and lymph nodes. Saitoh et al., "Metastatic Patterns of Prostatic Cancer. Correlation Between Sites And Number Of Organs Involved," Cancer, 54:3078-3084 (1984). At the time of clinical

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- 2 -

diagnosis, as many as 25% of patients have bone metastasis demonstrable by radionuclide scans. Murphy, G.P., et al., "The National Survey Of Prostate Cancer In The United States By The American College Of Surgeons," J. Urol., 127:928-939 (1982). Accurate clinical evaluation of nodal involvement has proven to be difficult. Imaging techniques such as computed tomography ("CT") or magnetic resonance ("MR") imaging are unable to distinguish metastatic prostate cancer involvement of lymph nodes by criterion other than size (i.e., > 1 cm). Therefore, by definition, these imaging modalities are inherently insensitive in the detection of small volume (< 1 cm) disease as well as non-specific in the detection of larger volume adenopathy. A recent study assessed the accuracy of MR in patients with clinically localized prostate cancer. Rifkin et al., "Comparison Of Magnetic Resonance Imaging And Ultrasonography In Staging Early Prostate Cancer," N. Engl. J. Med., 323:621-626 (1990). In this study, 194 patients underwent an MR and 185 of these patients had a lymph node dissection. 23 (13%) patients had pathologically involved lymph nodes. MR was suspicious in only 1 of these 23 cases resulting in a sensitivity of 4%. Similar results have also been noted with CT scans. Gasser et al., "MRI And Ultrasonography In Staging Prostate Cancer," N. Engl. J. Med. (Correspondence), 324(7):49-495 (1991).

The elevation of serum acid phosphatase activity in patients having metastasized prostate carcinoma was first reported by Gutman et al., J. Clin. Invest 17:473 (1938). In cancer of the prostate, prostatic acid phosphatase is released from the cancer tissue into the blood stream with the result that the total serum acid phosphatase level can be greatly increased above normal values. Numerous studies of this enzyme and its relation to prostatic cancer have been made since that time, e.g. Yar mer. J. Med. 56:604

- 3 -

(1974). However, the measurement of serum acid phosphatase is elevated in about 65-90 percent of patients having carcinoma of the prostate with bone metastasis; in about 30 percent of patients without  
5 roentgenological evidence of bone metastasis; and in about only 5-10 percent of patients lacking clinically demonstrable metastasis.

Prior art attempts to develop a specific test for prostatic acid phosphatase have met with only limited  
10 success, because techniques which rely on enzyme activity on a so-called "specific" substrate cannot take into account other biochemical and immunochemical differences among the many acid phosphatases which are unrelated to enzyme activity of prostate origin. In the case of  
15 isoenzymes, i.e. genetically defined enzymes having the same characteristic enzyme activity and a similar molecular structure but differing in amino acid sequences and/or content and, therefore, immunochemically distinguishable, it would appear inherently impossible to  
20 distinguish different isoenzyme forms merely by the choice of a particular substrate. It is, therefore, not surprising that none of these prior art methods is highly specific for the direct determination of prostatic acid phosphatase activity; e.g. see Cancer 5:236 (1952); J. Lab. Clin. Med. 82:486 (1973); Clin. Chem. Acta. 44:21  
25 (1973); and J. Physiol. Chem. 356:1775 (1975).

In addition to the aforementioned problems of non-specificity which appear to be inherent in many of the prior art reagents employed for the detection of  
30 prostate acid phosphatase, there have been reports of elevated serum acid phosphatase associated with other diseases, which further complicates the problem of obtaining an accurate clinical diagnosis of prostatic cancer. For example, Tuchman et al., Am. J. Med. 27:959  
35 (1959) noted that serum acid phosphatase levels appear to be elevated in patients with Gaucher's disease.

- 4 -

Due to the inherent difficulties in developing a "specific" substrate for prostate acid phosphatase, several researchers have developed immunochemical methods for the detection of prostate acid phosphatase. However, the previously reported immunochemical methods have drawbacks of their own which have precluded their widespread acceptance. For example, Shulman et al., Immunology 93:474 (1964) described an immuno-diffusion test for the detection of human prostate acid phosphatase. Using antisera prepared from a prostatic fluid antigen obtained by rectal massage from patients with prostatic disease, no cross-reactivity precipitin line was observed in the double diffusion technique against extracts of normal kidney, testicle, liver, and lung. However, this method has the disadvantages of limited sensitivity, even with the large amounts of antigen employed, and of employing antisera which may cross-react with other, antigenically unrelated serum protein components present in prostatic fluid.

WO 79/00475 to Chu et. al. describes a method for the detection of prostatic acid phosphatase isoenzyme patterns associated with prostatic cancer which obviates many of the above drawbacks. However, practical problems are posed by the need for a source of cancerous prostate tissue from which the diagnostically relevant prostatic acid phosphatase isoenzyme patterns associated with prostatic cancer are extracted for the preparation of antibodies thereto.

In recent years, considerable effort has been spent to identify enzyme or antigen markers for various types of malignancies with the view towards developing specific diagnostic reagents. The ideal tumor marker would exhibit, among other characteristics, tissue or cell-type specificity. Previous investigators have demonstrated the occurrence of human prostate tissue-specific antigens.

- 5 -

Treatment of Prostate Cancer

As described in W.J. Catalona, "Management of Cancer of the Prostate," New Engl. J. Med., 331(15):996-1004 (1994), the management of prostate cancer can be achieved by watchful waiting, curative treatment, and palliation.

For men with a life expectancy of less than 10 years, watchful waiting is appropriate where low-grade, low-stage prostate cancer is discovered at the time of a partial prostatectomy for benign hyperplasia. Such cancers rarely progress during the first five years after detection. On the other hand, for younger men, curative treatment is often more appropriate.

Where prostate cancer is localized and the patient's life expectancy is 10 years or more, radical prostatectomy offers the best chance for eradication of the disease. Historically, the drawback of this procedure is that most cancers had spread beyond the bounds of the operation by the time they were detected. However, the use of prostate-specific antigen testing has permitted early detection of prostate cancer. As a result, surgery is less extensive with fewer complications. Patients with bulky, high-grade tumors are less likely to be successfully treated by radical prostatectomy.

After surgery, if there are detectable serum prostate-specific antigen concentrations, persistent cancer is indicated. In many cases, prostate-specific antigen concentrations can be reduced by radiation treatment. However, this concentration often increases again within two years.

Radiation therapy has also been widely used as an alternative to radical prostatectomy. Patients generally treated by radiation therapy are those who are older and less healthy and those with higher-grade, more clinically advanced tumors. Particularly preferred procedures are external-beam therapy which involves three

- 6 -

dimensional, conformal radiation therapy where the field of radiation is designed to conform to the volume of tissue treated; interstitial-radiation therapy where seeds of radioactive compounds are implanted using  
5 ultrasound guidance; and a combination of external-beam therapy and interstitial-radiation therapy.

For treatment of patients with locally advanced disease, hormonal therapy before or following radical prostatectomy or radiation therapy has been utilized.  
10 Hormonal therapy is the main form of treating men with disseminated prostate cancer. Orchiectomy reduces serum testosterone concentrations, while estrogen treatment is similarly beneficial. Diethylstilbestrol, from estrogen is another useful hormonal therapy which has a  
15 disadvantage of causing cardiovascular toxicity. When gonadotropin-releasing hormone agonists are administered testosterone concentrations are ultimately reduced. Flutamide and other nonsteroidal, anti-androgen agents block binding of testosterone to its intracellular  
20 receptors. As a result, it blocks the effect of testosterone, increasing serum testosterone concentrations and allows patients to remain potent -- a significant problem after radical prostatectomy and radiation treatments.

25 Cytotoxic chemotherapy is largely ineffective in treating prostate cancer. Its toxicity makes such therapy unsuitable for elderly patients. In addition, prostate cancer is relatively resistant to cytotoxic agents.

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#### Use of Monoclonal Antibodies in Prostate Cancer Detection and Treatment

Theoretically, radiolabeled monoclonal  
35 antibodies ("mAbs") offer the potential to enhance both the sensitivity and specificity of detecting prostatic cancer within lymph nodes and elsewhere. While many mAbs have previously been prepared against prostate related



- 7 -

- antigens, none of these mAbs were specifically generated with an imaging objective in mind. Nevertheless, the clinical need has led to evaluation of some of these mAbs as possible imaging agents. Vihko et al., "Radioimaging of Prostatic Carcinoma With Prostatic Acid Phosphatase - Specific Antibodies," Biotechnology in Diagnostics, 131-134 (1985); Babaian et al., "Radioimmunological Imaging of Metastatic Prostatic Cancer With 111-Indium-Labeled Monoclonal Antibody PAY 276," J. Urol., 137:439-443 (1987); Leroy et al., "Radioimmunodetection Of Lymph Node Invasion In Prostatic Cancer. The Use Of Iodine 123 (123-I)-Labeled Monoclonal Anti-Prostatic Acid Phosphatase (PAP) 227 A F (ab') 2 Antibody Fragments In Vivo," Cancer, 64:1-5 (1989); Meyers et al., "Development Of Monoclonal Antibody Imaging Of Metastatic Prostatic Carcinoma," The Prostate, 14:209-220 (1989).

In some cases, the monoclonal antibodies developed for detection and/or treatment of prostate cancer recognize antigens specific to malignant prostatic tissues. Such antibodies are thus used to distinguish malignant prostatic tissue (for treatment or detection) from benign prostatic tissue. See U.S. Patent No. 4,970,299 to Bazinet et al. and U.S. Patent No. 4,902,615 to Freeman et al.

Other monoclonal antibodies react with surface antigens on all prostate epithelial cells whether cancerous or benign. See U.S. Patent Nos. 4,446,122 and Re 33,405 to Chu et al., U.S. Patent No. 4,863,851 to McEwan et al., and U.S. Patent No. 5,055,404 to Ueda et al. However, the antigens detected by these monoclonal antibodies are present in the blood and, therefore, compete with antigens at tumor sites for the monoclonal antibodies. This causes background noise which makes the use of such antibodies inadequate for *in vivo* imaging. In therapy, such antibodies, if bound to a cytotoxic agent, could be harmful to other organs.

- 8 -

Horoszewicz et al., "Monoclonal Antibodies to a New Antigenic Marker in Epithelial Prostatic Cells and Serum of Prostatic Cancer Patients," Anticancer Research, 7:927-936 (1987) ("Horoszewicz") and U.S. Patent No. 5,162,504 to Horoszewicz describe an antibody, designated 7E11, which recognizes prostate specific membrane antigen ("PSMA"). Israeli et al., "Molecular Cloning of a Complementary DNA Encoding a Prostate-specific Membrane Antigen," Cancer Research, 53:227-230 (1993) ("Israeli") describes the cloning and sequencing of PSMA and reports that PSMA is prostate-specific and shows increased expression levels in metastatic sites and in hormone-refractory states. Other studies have indicated that PSMA is more strongly expressed in prostate cancer cells relative to cells from the normal prostate or from a prostate with benign hyperplasia. Furthermore, PSMA is not found in serum (Troyer et al., "Detection and Characterization of the Prostate-Specific Membrane Antigen (PSMA) in Tissue Extracts and Body Fluids," Int. J. Cancer, 62:552-558 (1995)).

These characteristics make PSMA an attractive target for antibody mediated targeting for imaging and therapy of prostate cancer. Imaging studies using indium-labeled 7E11 have indicated that the antibody localizes quite well to both the prostate and to sites of metastasis. In addition, 7E11 appears to have clearly improved sensitivity for detecting lesions compared to other currently available imaging techniques, such as CT and MR imaging or bone scan. Bander, "Current Status of Monoclonal Antibodies for Imaging and Therapy of Prostate Cancer," Sem. In Oncology, 21:607-612 (1994).

However, the use of 7E11 and other known antibodies to PSMA to mediate imaging and therapy has several disadvantages. First, PSMA is an integral membrane protein known to have a short intracellular tail and a long extracellular domain. Biochemical characterization and mapping (Troyer et al., "Biochemical

- 9 -

Characterization and Mapping of the 7E11-C5.3 Epitope of the Prostate-specific Membrane Antigen," Urol. Oncol., 1:29-37 (1995)) have shown that the epitope or antigenic site to which the 7E11 antibody binds is present on the intracellular portion of the molecule. Because antibody molecules do not, under normal circumstances, cross the cell membrane unless they bind to the extracellular portion of a molecule and become translocated intracellularly, the 7E11 antibody does not have access to its antigenic target site in an otherwise healthy, viable cell.

Consequently, imaging using 7E11 is limited to the detection of dead cells within tumor deposits. Additionally, the therapeutic use of the 7E11 antibody is limited, because only cells that are already dead or tissue containing a large proportion of dead cells can be effectively targeted.

Although the inadequacies and problems in the diagnosis and treatment of one particular type of cancer are the focus of the preceding discussion, prostate cancer is merely a representative model. The diagnosis and treatment of numerous other cancers have similar problems.

The present invention is directed to overcoming the deficiencies of prior art antibodies in diagnosing and treating prostate and other types of cancer.

#### SUMMARY OF THE INVENTION

One aspect of the present invention relates to a method of ablating or killing cancerous cells. The process involves providing a biological agent which, when contacted with an extracellular domain of prostate specific membrane antigen, recognizes the extracellular domain of prostate specific membrane antigen. These biological agents are contacted with vascular endothelial cells proximate to the cancerous cells under conditions

- 10 -

effective to permit both binding of the biological agent to the vascular endothelial cells proximate to the cancerous cells and killing or ablating of the cancerous cells. The biological agent can be used alone or can be  
5 bound to a substance effective to kill or ablate the cancerous cells upon binding of the biological agent to vascular endothelial cells that are proximate to the cancerous cells.

In a particularly preferred embodiment of the  
10 method of ablating or killing cancerous cells in accordance with the present invention, the biological agent, when contacted with an extracellular domain of prostate specific membrane antigen, binds to and is internalized with the prostate specific membrane antigen  
15 of such cells. Preferred biological agents for use in the method of ablating or killing cancerous cells in accordance with the present invention are antibodies or binding portions thereof, probes, or ligands. The methods of the present invention are particularly useful  
20 in killing or ablating renal, urothelial, colon, rectal, lung, and breast cancerous cells and cancerous cells of metastatic adenocarcinoma to the liver.

Another aspect of the present invention relates to a method of detecting cancerous tissue in a biological  
25 sample. This method involves providing a biological agent which, when contacted with an extracellular domain of prostate specific membrane antigen, binds to the extracellular domain of prostate specific membrane antigen. The biological agent is bound to a label  
30 effective to permit detection of vascular endothelial cells proximate to or within the cancerous tissue upon binding of the biological agent to the vascular endothelial cells proximate to or within the cancerous tissue. The biological sample is contacted with the  
35 biological agent having a label under conditions effective to permit binding of the biological agent to the vascular endothelial cells proximate to or within the

- 11 -

cancerous tissue in the biological sample. The presence of cancerous tissue in the biological sample is detected by detection of the label.

5 In a particularly preferred embodiment of the method of detecting cancerous tissue in accordance with the present invention, the biological agent is one that, when contacted with an extracellular domain of prostate specific membrane antigen, binds to and is internalized with the prostate specific membrane antigen. Preferred  
10 biological agents for use in the method of detecting cancerous tissue in accordance with the present invention are antibodies or binding portions thereof, probes, or ligands. The method is especially useful in detecting renal, urothelial, colon, rectal, lung, and breast  
15 cancerous tissue and cancerous tissue of metastatic adenocarcinoma to the liver.

Still another aspect of the present invention relates to a method of ablating or killing normal, benign hyperplastic, and cancerous prostate epithelial cells.  
20 The process involves providing a biological agent which recognizes an extracellular domain of prostate specific membrane antigen. The biological agent can be used alone or can be bound to a substance effective to kill the cells upon binding of the biological agent to the cells.  
25 These biological agents are then contacted with the cells under conditions effective to permit both binding of the biological agent to the extracellular domain of the prostate specific membrane antigen and killing or ablating of the cells.

30 In a particularly preferred embodiment of the method of ablating or killing normal, benign hyperplastic, and cancerous prostate epithelial cells in accordance with the present invention, the biological agent binds to and is internalized with the prostate  
35 specific membrane antigen of such cells. Preferred biological agents for use in the method of ablating or killing normal, benign hyperplastic, and cancerous

- 12 -

prostate epithelial cells in accordance with the present invention are antibodies or binding portions thereof, probes, or ligands.

Another aspect of the present invention relates to a method of detecting normal, benign hyperplastic, and cancerous prostate epithelial cells or portions thereof in a biological sample. This method involves providing a biological agent which binds to an extracellular domain of prostate specific membrane antigen. The biological agent is bound to a label effective to permit detection of the cells or portions thereof upon binding of the biological agent to the cells or portions thereof. The biological sample is contacted with the biological agent having a label under conditions effective to permit binding of the biological agent to the extracellular domain of the prostate specific membrane antigen of any of the cells or portions thereof in the biological sample. The presence of any cells or portions thereof in the biological sample is detected by detection of the label.

In a particularly preferred embodiment of the method of detecting normal, benign hyperplastic, and cancerous prostate epithelial cells in accordance with the present invention, the biological agent binds to and is internalized with the prostate specific membrane antigen of such cells. Preferred biological agents for use in the method of detecting normal, benign hyperplastic, and cancerous prostate epithelial cells in accordance with the present invention are antibodies or binding portions thereof, probes, or ligands.

Another aspect of the present invention pertains to a biological agent that recognizes an extracellular domain of prostate specific membrane antigen. In a preferred embodiment, the isolated biological agent binds to and is internalized with the prostate specific membrane antigen. Preferred isolated biological agents which recognize an extracellular domain

- 13 -

of prostate specific membrane antigen in accordance with the present invention are isolated antibodies or binding portions thereof, probes, or ligands. Hybridoma cell lines that produce monoclonal antibodies of these types  
5 are also disclosed.

The biological agents of the present invention recognize the extracellular domain of antigens of normal, benign hyperplastic, and cancerous prostate epithelial cells. Unlike the 7E11 antibody, which recognizes an  
10 epitope of prostate-associated antigens which are exposed extracellularly only after cell lysis, the biological agents of the present invention bind to antigenic epitopes which are extracellularly exposed in living prostate cells. Using the biological agents of the  
15 present invention, living, unfixed normal, benign hyperplastic, and cancerous prostate epithelial cells can be targeted, which makes treatment and diagnosis more effective. In a preferred embodiment for treating prostate cancer, the biological agents of the present  
20 invention also bind to and are internalized with the prostate specific membrane antigen, which permits the therapeutic use of intracellularly acting cytotoxic agents.

25 BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is an immuno-electron micrograph of gold-labeled monoclonal antibody J591 on the surface of LNCaP cells after incubation at 4°C.

30 Figure 2 is an immuno-electron micrograph of LNCaP cells treated with gold-labeled monoclonal antibody J591 after 5 minutes incubation at 37°C.

Figure 3 is an immuno-electron micrograph of LNCaP cells treated with gold-labeled monoclonal antibody  
35 J591 after 10 minutes incubation at 37°C.

- 14 -

Figure 4 is an immuno-electron micrograph of LNCaP cells treated with gold-labeled monoclonal antibody J591 after 15 minutes incubation at 37°C.

5 Figure 5 is an immuno-electron micrograph of LNCaP cells treated with gold-labeled monoclonal antibody J591 after 15 minutes at 37°C showing J591 within endosomes.

Figure 6 summarizes the sequencing strategy of the heavy chain of monoclonal antibody J591.

10 Figure 7 shows the nucleotide sequence of the heavy chain of monoclonal antibody J591 (designated SEQ.ID. No. 1), the nucleotide sequence of the corresponding reverse, non-coding strand (designated SEQ. ID. No. 2), and the corresponding deduced amino acid  
15 sequences (designated SEQ. ID. Nos. 3, 4, and 5).

Figure 8 is a comparison of the heavy chain of monoclonal antibody J591 with the consensus sequence for Mouse Heavy Chains Subgroup IIA.

20 Figure 9 summarizes the sequencing strategy of the kappa light chain of monoclonal antibody J591.

Figure 10 shows the nucleotide sequences of the kappa light chain of monoclonal antibody J591 (designated SEQ.ID. No. 9), the nucleotide sequence of the corresponding reverse, non-coding strand (designated SEQ.  
25 ID. No. 10), and the corresponding deduced amino acid sequence (designated SEQ. ID. Nos. 11, 12, and 13).

Figure 11 is a comparison of the kappa light chain of monoclonal antibody J591 with the consensus sequence for Mouse Kappa Chains Subgroup V.

30 Figures 12A-12F are micrographs (250 x magnification) showing the immunohistochemical reactivity of mAb J591 to neovasculature of various carcinomas.

#### DETAILED DESCRIPTION OF THE INVENTION

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One aspect of the present invention relates to a method of ablating or killing normal, benign



- 15 -

hyperplastic, and cancerous prostate epithelial cells. The process involves providing a biological agent, such as an antibody or binding portion thereof, probe, or ligand, which binds to an extracellular domain of

5 prostate specific membrane antigen of (i.e., a portion of prostate specific membrane antigen which is external to) such cells. The biological agent can be used alone or can be bound to a substance effective to kill the cells upon binding of the biological agent to the cells. These

10 biological agents are then contacted with the cells under conditions effective to permit both binding of the biological agent to the extracellular domain of the prostate specific membrane antigen and killing or ablating of the cells. In its preferred form, such

15 contacting is carried out in a living mammal by administering the biological agent to the mammal under conditions effective to permit both binding of the biological agent to the extracellular domain of the prostate specific membrane antigen and killing or

20 ablating of the cells. Such administration can be carried out orally or parenterally.

In a particularly preferred embodiment of the method of ablating or killing normal, benign hyperplastic, and cancerous prostate epithelial cells in

25 accordance with the present invention, the biological agent binds to and is internalized with the prostate specific membrane antigen of such cells. Again, the biological agent can be used alone. Alternatively, the biological agent can be bound to a substance effective to

30 kill the cells upon binding of the biological agent to prostate specific membrane antigen and upon internalization of the biological agent with the prostate specific membrane antigen.

The mechanism by which the biological agent is

35 internalized with the prostate specific membrane antigen is not critical to the practice of the present invention. For example, the biological agent can induce

- 16 -

internalization of the prostate specific membrane antigen. Alternatively, internalization of the biological agent can be the result of routine internalization of prostate specific membrane antigen.

5           The above-described biological agents (i.e., biological agents, such as an antibody or binding portion thereof, probe, or ligand which, when contacted with an extracellular domain of prostate specific membrane antigen, recognizes the extracellular domain of prostate  
10 specific membrane antigen and, preferably, is internalized therewith) can be used to ablate or kill cancerous cells. In this aspect of the present invention, the biological agent can be used alone or can be bound to a substance effective to kill the cancerous  
15 cells upon binding of the biological agent to vascular endothelial cells proximate thereto. These biological agents are contacted with vascular endothelial cells proximate to the cancerous cells. The contacting is carried out under conditions that are effective to permit  
20 binding of the biological agent to the vascular endothelial cells proximate to the cancerous cells and, in addition, that are effective to kill or ablate the cancerous cells. The mechanism by which the cancerous cells are killed or ablated is not critical to the  
25 practice of the present invention. For example, the cancerous cells can be killed or ablated directly by the biological agent as a consequence of their proximity to the vascular endothelial cells to which the biological agent binds. Alternatively, the biological agent can  
30 kill, ablate, or otherwise change the properties of the vascular endothelial cells to which it binds so that blood flow to the cancerous cells proximate thereto is stopped or otherwise reduced, thereby causing the cancerous cells to be killed or ablated. Thus, the  
35 method of the present invention is particularly useful for killing or ablating vascular endothelial cells in

- 17 -

cancerous tissue as well as the cancerous cells contained in cancerous tissue.

In a particularly preferred embodiment of the method of ablating or killing cancerous cells in accordance with the present invention, the biological agent employed is one that, when contacted with an extracellular domain of prostate specific membrane antigen, binds to and is internalized with the extracellular domain of prostate specific membrane antigen. The methods of the present invention are particularly useful to kill or ablate cancerous prostate epithelial cells as well as cancerous cells other than cancerous prostate epithelial cells. Examples of cancerous cells which are not cancerous prostate epithelial cells are renal, urothelial, colon, rectal, lung, and breast cancerous cells and cancerous cells of metastatic adenocarcinoma to the liver. Although the method of the present invention can be used to kill or ablate any cell which expresses an extracellular domain of prostate specific membrane antigen or a portion thereof or whose subsistence is dependent upon cells which express an extracellular domain of prostate specific membrane antigen or a portion thereof, the method of the present invention is particularly useful to kill or ablate cancerous cells, because the vascular endothelial cells supplying blood to cancerous tissues (e.g., tumors, collections of cancerous cells, or other cancerous masses) express an extracellular domain of prostate specific membrane antigen, irrespective of the type of cancer involved. In contrast, vascular endothelial cells supplying blood to normal tissues do not express an extracellular domain of prostate specific membrane antigen.

Another aspect of the present invention relates to a method of detecting normal, benign hyperplastic, and cancerous epithelial cells or portions thereof in a biological sample. This method involves providing a

- 18 -

biological agent, such as an antibody or binding portion thereof, probe, or ligand, which binds to an extracellular domain of prostate specific membrane antigen of such cells. The biological agent is bound to a label effective to permit detection of the cells or portions (e.g., prostate specific membrane antigen or fragments thereof liberated from such normal, benign hyperplastic, and cancerous cells) thereof upon binding of the biological agent to the cells or portions thereof.

The biological sample is contacted with the biological agent having a label under conditions effective to permit binding of the biological agent to the extracellular domain of the prostate specific membrane antigen of any of the cells or portions thereof in the biological sample. The presence of any cells or portions thereof in the biological sample is detected by detection of the label. In its preferred form, such contacting is carried out in a living mammal and involves administering the biological agent to the mammal under conditions effective to permit binding of the biological agent to the prostate specific membrane antigen of any of the cells or portions thereof in the biological sample. Again, such administration can be carried out orally or parenterally.

The method of the present invention can be used to screen patients for diseases associated with the presence of normal, benign hyperplastic, and cancerous epithelial cells or portions thereof. Alternatively, it can be used to identify the recurrence of such diseases, particularly when the disease is localized in a particular biological material of the patient. For example, recurrence of prostatic disease in the prostatic fossa may be encountered following radical prostatectomy. Using the method of the present invention, this recurrence can be detected by administering a short range radiolabeled antibody to the mammal and then detecting the label rectally, such as with a transrectal detector probe.

- 19 -

Alternatively, the contacting step can be carried out in a sample of serum or urine or other body fluids, such as to detect the presence of PSMA in the body fluid. When the contacting is carried out in a serum or urine sample, it is preferred that the biological agent recognize substantially no antigens circulating in the blood other than PSMA. Since intact prostate cells do not excrete or secrete PSMA into the extracellular environment, detecting PSMA in serum, urine, or other body fluids generally indicates that prostate cells are being lysed. Thus, the biological agents and methods of the present invention can be used to determine the effectiveness of a prostate cancer treatment protocol by monitoring the level of PSMA in serum, urine or other body fluids.

In a particularly preferred embodiment of the method of detecting normal, benign hyperplastic, and cancerous prostate epithelial cells in accordance with the present invention, the biological agent, such as the antibody or binding portion thereof, probe, or ligand, binds to and is internalized with the prostate specific membrane antigen of such cells. Again, the biological agent is bound to a label effective to permit detection of the cells or portions thereof upon binding of the biological agent to and internalization of the biological agent with the prostate specific membrane antigen.

Another aspect of the present invention relates to a method of detecting cancerous tissue in a biological sample. This method involves providing the above-described biological agent (i.e., a biological agent, such as an antibody or binding portion thereof, probe, or ligand which, when contacted with an extracellular domain of prostate specific membrane antigen, recognizes the extracellular domain of prostate specific membrane antigen). The biological agent is bound to a label that is effective to permit detection of vascular endothelial cells proximate to or within the cancerous tissue upon

- 20 -

binding of the biological agent to vascular endothelial cells proximate to or within the cancerous tissue. The biological sample is then contacted with the biological agent having a label. Contacting is carried out under  
5 conditions effective to permit binding of the biological agent to the vascular endothelial cells proximate to or within the cancerous tissue in the biological sample. The presence of cancerous cells or portions thereof in the biological sample is detected by detection of the  
10 label.

Rather than contacting the entire biological sample with the biological agent, it is contemplated that a portion of the biological sample can be used. For example, a tissue biopsy sample can be contacted with the  
15 biological agent to determine the presence of cancerous tissue in the tissue biopsy sample as well as in the larger biological sample from which it is taken. Alternatively, the biological agent can be contacted with a serum or urine sample to ascertain whether any vascular  
20 endothelial cells expressing an extracellular domain of prostate specific membrane antigen are present therein. Since vascular endothelial cells expressing an extracellular domain of prostate specific membrane antigen are found in the vasculature of cancerous tissues  
25 but not in the vasculature of normal tissues, detection of the label in a serum or urine sample indicates the presence of cancerous tissue in the larger biological sample from which it is taken (e.g., a patient).

In a particularly preferred embodiment of the  
30 method of detecting cancerous tissues in accordance with the present invention, the biological agent employed is one that, when contacted with an extracellular domain of prostate specific membrane antigen, binds to and is internalized with the prostate specific membrane antigen.  
35 The methods of the present invention can be used to detect cancerous prostate epithelial cells as well as cancerous tissues containing cancerous cells other than

- 21 -

cancerous prostate epithelial cells. Examples of cancerous tissues containing cancerous cells other than cancerous prostate epithelial cells which can be detected with the methods of the present invention include renal, urothelial, colon, rectal, lung, and breast cancerous tissue and cancerous tissue of metastatic adenocarcinoma to the liver.

As indicated above, biological agents suitable for either killing, ablating, or detecting cancerous cells and normal, benign hyperplastic, and cancerous prostate epithelial cells include antibodies, such as monoclonal or polyclonal antibodies. In addition, antibody fragments, half-antibodies, hybrid derivatives, probes, and other molecular constructs may be utilized. These biological agents, such as antibodies, binding portions thereof, probes, or ligands, bind to extracellular domains of prostate specific membrane antigens or portions thereof in normal, benign hyperplastic, and cancerous prostate epithelial cells. As a result, when practicing the methods of the present invention to kill, ablate, or detect normal, benign hyperplastic, and cancerous prostate epithelial cells, the biological agents bind to all such cells, not only to cells which are fixed or cells whose intracellular antigenic domains are otherwise exposed to the extracellular environment. Consequently, binding of the biological agents is concentrated in areas where there are prostate epithelial cells, irrespective of whether these cells are fixed or unfixed, viable or necrotic. Additionally or alternatively, these biological agents, such as antibodies, binding portions thereof, probes, or ligands, bind to and are internalized with prostate specific membrane antigens or portions thereof in normal, benign hyperplastic, and cancerous prostate epithelial cells.

Monoclonal antibody production may be effected by techniques which are well-known in the art.

- 22 -

Basically, the process involves first obtaining immune cells (lymphocytes) from the spleen of a mammal (e.g., mouse) which has been previously immunized with the antigen of interest either *in vivo* or *in vitro*. The antibody-secreting lymphocytes are then fused with (mouse) myeloma cells or transformed cells, which are capable of replicating indefinitely in cell culture, thereby producing an immortal, immunoglobulin-secreting cell line. The resulting fused cells, or hybridomas, are cultured, and the resulting colonies screened for the production of the desired monoclonal antibodies. Colonies producing such antibodies are cloned, and grown either *in vivo* or *in vitro* to produce large quantities of antibody. A description of the theoretical basis and practical methodology of fusing such cells is set forth in Kohler and Milstein, Nature 256:495 (1975), which is hereby incorporated by reference.

Mammalian lymphocytes are immunized by *in vivo* immunization of the animal (e.g., a mouse) with the protein or polypeptide of the present invention. Such immunizations are repeated as necessary at intervals of up to several weeks to obtain a sufficient titer of antibodies. Following the last antigen boost, the animals are sacrificed and spleen cells removed.

Fusion with mammalian myeloma cells or other fusion partners capable of replicating indefinitely in cell culture is effected by standard and well-known techniques, for example, by using polyethylene glycol ("PEG") or other fusing agents (See Milstein and Kohler, Eur. J. Immunol. 6:511 (1976), which is hereby incorporated by reference). This immortal cell line, which is preferably murine, but may also be derived from cells of other mammalian species, including but not limited to rats and humans, is selected to be deficient in enzymes necessary for the utilization of certain nutrients, to be capable of rapid growth, and to have good fusion capability. Many such cell lines are known



- 23 -

to those skilled in the art, and others are regularly described.

Procedures for raising polyclonal antibodies are also well known. Typically, such antibodies can be raised by administering the protein or polypeptide of the present invention subcutaneously to New Zealand white rabbits which have first been bled to obtain pre-immune serum. The antigens can be injected at a total volume of 100  $\mu$ l per site at six different sites. Each injected material will contain synthetic surfactant adjuvant pluronic polyols, or pulverized acrylamide gel containing the protein or polypeptide after SDS-polyacrylamide gel electrophoresis. The rabbits are then bled two weeks after the first injection and periodically boosted with the same antigen three times every six weeks. A sample of serum is then collected 10 days after each boost. Polyclonal antibodies are then recovered from the serum by affinity chromatography using the corresponding antigen to capture the antibody. Ultimately, the rabbits are euthenized with pentobarbital 150 mg/Kg IV. This and other procedures for raising polyclonal antibodies are disclosed in E. Harlow, et. al., editors, Antibodies: A Laboratory Manual (1988), which is hereby incorporated by reference.

In addition to utilizing whole antibodies, the processes of the present invention encompass use of binding portions of such antibodies. Such binding portions include Fab fragments, F(ab')<sub>2</sub> fragments, and Fv fragments. These antibody fragments can be made by conventional procedures, such as proteolytic fragmentation procedures, as described in J. Goding, Monoclonal Antibodies: Principles and Practice, pp. 98-118 (N.Y. Academic Press 1983), which is hereby incorporated by reference.

Alternatively, the processes of the present invention can utilize probes or ligands found either in nature or prepared synthetically by recombinant DNA

- 24 -

procedures or other biological or molecular procedures. Suitable probes or ligands are molecules which bind to the extracellular domains of prostate specific membrane antigens identified by the monoclonal antibodies of the present invention. Other suitable probes or ligands are molecules which bind to and are internalized with prostate specific membrane antigens. Such probes or ligands can be, for example, proteins, peptides, lectins, or nucleic acid probes.

It is particularly preferred to use the monoclonal antibodies identified below in Table 1.

TABLE 1

	<u>Monoclonal Antibody Name</u>	<u>ATCC Designation for Hybridoma Cell Line</u>
15	E99	HB-12101
	J415	HB-12109
	J533	HB-12127
20	J591	HB-12126

These antibodies can be used alone or as a component in a mixture with other antibodies or other biological agents to treat cancers or image cancerous tissues (particularly the vascular endothelial cells therein) or prostate epithelial cells with varying surface antigen characteristics.

Regardless of whether the biological agents are used for treatment or diagnosis, they can be administered orally, parenterally, subcutaneously, intravenously, intramuscularly, intraperitoneally, by intranasal instillation, by intracavitary or intravesical instillation, intraocularly, intraarterially, intralesionally, or by application to mucous membranes, such as, that of the nose, throat, and bronchial tubes. They may be administered alone or with pharmaceutically or physiologically acceptable carriers, excipients, or stabilizers, and can be in solid or liquid form such as,

- 25 -

tablets, capsules, powders, solutions, suspensions, or emulsions.

The solid unit dosage forms can be of the conventional type. The solid form can be a capsule, such as an ordinary gelatin type containing the biological agent, such as an antibody or binding portion thereof, of the present invention and a carrier, for example, lubricants and inert fillers such as, lactose, sucrose, or cornstarch. In another embodiment, these compounds are tableted with conventional tablet bases such as lactose, sucrose, or cornstarch in combination with binders like acacia, cornstarch, or gelatin, disintegrating agents such as, cornstarch, potato starch, or alginic acid, and a lubricant like stearic acid or magnesium stearate.

The biological agent of the present invention may also be administered in injectable dosages by solution or suspension of these materials in a physiologically acceptable diluent with a pharmaceutical carrier. Such carriers include sterile liquids such as water and oils, with or without the addition of a surfactant and other pharmaceutically and physiologically acceptable carrier, including adjuvants, excipients or stabilizers. Illustrative oils are those of petroleum, animal, vegetable, or synthetic origin, for example, peanut oil, soybean oil, or mineral oil. In general, water, saline, aqueous dextrose and related sugar solution, and glycols such as, propylene glycol or polyethylene glycol, are preferred liquid carriers, particularly for injectable solutions.

For use as aerosols, the biological agent of the present invention in solution or suspension may be packaged in a pressurized aerosol container together with suitable propellants, for example, hydrocarbon propellants like propane, butane, or isobutane with conventional adjuvants. The materials of the present

- 26 -

invention also may be administered in a non-pressurized form such as in a nebulizer or atomizer.

The biological agents may be utilized to detect cancerous tissues (particularly the vascular endothelial cells therein) and normal, benign hyperplastic, and cancerous prostate epithelial cells *in vivo*. This is achieved by labeling the biological agent, administering the labeled biological agent to a mammal, and then imaging the mammal.

Examples of labels useful for diagnostic imaging in accordance with the present invention are radiolabels such as  $^{131}\text{I}$ ,  $^{111}\text{In}$ ,  $^{123}\text{I}$ ,  $^{99\text{m}}\text{Tc}$ ,  $^{32}\text{P}$ ,  $^{125}\text{I}$ ,  $^3\text{H}$ ,  $^{14}\text{C}$ , and  $^{188}\text{Rh}$ , fluorescent labels such as fluorescein and rhodamine, nuclear magnetic resonance active labels, positron emitting isotopes detectable by a positron emission tomography ("PET") scanner, chemiluminescers such as luciferin, and enzymatic markers such as peroxidase or phosphatase. Short-range radiation emitters, such as isotopes detectable by short-range detector probes, such as a transrectal probe, can also be employed. These isotopes and transrectal detector probes, when used in combination, are especially useful in detecting prostatic fossa recurrences and pelvic nodal disease. The biological agent can be labeled with such reagents using techniques known in the art. For example, see Wensel and Meares, Radioimmunoimaging and Radioimmunotherapy, Elsevier, New York (1983), which is hereby incorporated by reference, for techniques relating to the radiolabeling of antibodies. See also, D. Colcher et al., "Use of Monoclonal Antibodies as Radiopharmaceuticals for the Localization of Human Carcinoma Xenografts in Athymic Mice", Meth. Enzymol. 121: 802-816 (1986), which is hereby incorporated by reference.

A radiolabeled biological agent of this invention can be used for *in vitro* diagnostic tests. The specific activity of a tagged biological agent, such as a

- 27 -

tagged antibody, binding portion thereof, probe, or ligand, depends upon the half-life, the isotopic purity of the radioactive label, and how the label is incorporated into the biological agent. Table 2 lists several commonly-used isotopes, their specific activities and half-lives. In immunoassay tests, the higher the specific activity, in general, the better the sensitivity.

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TABLE 2

15	<u>Isotope</u>	<u>Specific Activity of Pure Isotope (Curies/mole)</u>	<u>Half-Life</u>
	$^{14}\text{C}$	$6.25 \times 10^4$	5720 years
	$^3\text{H}$	$2.01 \times 10^4$	12.5 years
	$^{35}\text{S}$	$1.50 \times 10^6$	87 days
	$^{125}\text{I}$	$2.18 \times 10^6$	60 days
20	$^{32}\text{P}$	$3.16 \times 10^6$	14.3 days
	$^{131}\text{I}$	$1.62 \times 10^7$	8.1 days

Procedures for labeling biological agents with the radioactive isotopes listed in Table 2 are generally known in the art. Tritium labeling procedures are described in U.S. Patent No. 4,302,438, which is hereby incorporated by reference. Iodinating, tritium labeling, and  $^{35}\text{S}$  labeling procedures especially adapted for murine monoclonal antibodies are described by Goding, J.W. (supra, pp 124-126) and the references cited therein, which are hereby incorporated by reference. Other procedures for iodinating biological agents, such as antibodies, binding portions thereof, probes, or ligands, are described by Hunter and Greenwood, Nature 144:945 (1962), David et al., Biochemistry 13:1014-1021 (1974), and U.S. Patent Nos. 3,867,517 and 4,376,110, which are hereby incorporated by reference. Radiolabeling elements which are useful in imaging include  $^{123}\text{I}$ ,  $^{131}\text{I}$ ,  $^{111}\text{In}$ , and  $^{99\text{m}}\text{Tc}$ , for example. Procedures for iodinating biological agents are described by Greenwood, F. et al., Biochem. J. 89:114-123 (1963); Marchalonis, J., Biochem. J. 113:299-305 (1969); and Morrison, M. et al.,

- 28 -

Immunochemistry, 289-297 (1971), which are hereby incorporated by reference. Procedures for  $^{99m}\text{Tc}$ -labeling are described by Rhodes, B. et al. in Burchiel, S. et al. (eds.), Tumor Imaging: The Radioimmunochemical Detection of Cancer, New York: Masson 111-123 (1982) and the references cited therein, which are hereby incorporated by reference. Procedures suitable for  $^{111}\text{In}$ -labeling biological agents are described by Hnatowich, D.J. et al., J. Immunol. Methods, 65:147-157 (1983), Hnatowich, D. et al., J. Applied Radiation, 35:554-557 (1984), and Buckley, R. G. et al., F.E.B.S. 166:202-204 (1984), which are hereby incorporated by reference.

In the case of a radiolabeled biological agent, the biological agent is administered to the patient, is localized to the tumor bearing the antigen with which the biological agent reacts, and is detected or "imaged" in vivo using known techniques such as radionuclear scanning using e.g., a gamma camera or emission tomography. See e.g., A.R. Bradwell et al., "Developments in Antibody Imaging", Monoclonal Antibodies for Cancer Detection and Therapy, R.W. Baldwin et al., (eds.), pp. 65-85 (Academic Press 1985), which is hereby incorporated by reference. Alternatively, a positron emission transaxial tomography scanner, such as designated Pet VI located at Brookhaven National Laboratory, can be used where the radiolabel emits positrons (e.g.,  $^{11}\text{C}$ ,  $^{18}\text{F}$ ,  $^{15}\text{O}$ , and  $^{13}\text{N}$ ).

Fluorophore and chromophore labeled biological agents can be prepared from standard moieties known in the art. Since antibodies and other proteins absorb light having wavelengths up to about 310 nm, the fluorescent moieties should be selected to have substantial absorption at wavelengths above 310 nm and preferably above 400 nm. A variety of suitable fluorescers and chromophores are described by Stryer, Science, 162:526 (1968) and Brand, L. et al., Annual Review of Biochemistry, 41:843-868 (1972), which are hereby incorporated by reference. The biological agents

can be labeled with fluorescent chromophore groups by conventional procedures such as those disclosed in U.S. Patent Nos. 3,940,475, 4,289,747, and 4,376,110, which are hereby incorporated by reference.

5           One group of fluorescers having a number of the desirable properties described above are the xanthene dyes, which include the fluoresceins derived from 3,6-dihydroxy-9-henylxanthhydrol and resamines and rhodamines derived from 3,6-diamino-9-phenylxanthhydrol  
10 and lissanime rhodamine B. The rhodamine and fluorescein derivatives of 9-o-carboxyphenylxanthhydrol have a 9-o-carboxyphenyl group. Fluorescein compounds having reactive coupling groups such as amino and isothiocyanate groups such as fluorescein isothiocyanate and  
15 fluorescamine are readily available. Another group of fluorescent compounds are the naphthylamines, having an amino group in the  $\alpha$  or  $\beta$  position.

          Biological agents can be labeled with fluorchromes or chromophores by the procedures described  
20 by Goding, J. (supra, pp 208-249). The biological agents can be labeled with an indicating group containing the NMR-active  $^{19}\text{F}$  atom, or a plurality of such atoms inasmuch as (i) substantially all of naturally abundant fluorine atoms are the  $^{19}\text{F}$  isotope and, thus, substantially all  
25 fluorine-containing compounds are NMR-active; (ii) many chemically active polyfluorinated compounds such as trifluoroacetic anhydride are commercially available at relatively low cost, and (iii) many fluorinated compounds have been found medically acceptable for use in humans  
30 such as the perfluorinated polyethers utilized to carry oxygen as hemoglobin replacements. After permitting such time for incubation, a whole body NMR determination is carried out using an apparatus such as one of those described by Pykett, Scientific American, 246:78-88  
35 (1982), which is hereby incorporated by reference, to locate and image cancerous tissues (particularly the

- 30 -

vascular endothelial cells therein) and prostate epithelial cells.

In cases where it is important to distinguish between regions containing live and dead prostate epithelial cells or to distinguish between live and dead prostate epithelial cells, the antibodies of the present invention (or other biological agents of the present invention), labeled as described above, can be coadministered along with an antibody or other biological agent which recognizes only living or only dead prostate epithelial cells labeled with a label which can be distinguished from the label used to label the subject antibody. By monitoring the concentration of the two labels at various locations or times, spatial and temporal concentration variations of living and dead normal, benign hyperplastic, and cancerous prostate epithelial cells can be ascertained. In particular, this method can be carried out using the labeled antibodies of the present invention, which recognize both living and dead epithelial prostate cells, and labeled 7E11 antibodies, which recognize only dead epithelial prostate cells.

The biological agents can also be utilized to kill or ablate cancerous cells and normal, benign hyperplastic, and cancerous prostate epithelial cells in vivo. This involves using the biological agents by themselves or with a cytotoxic drug to which the biological agents of the present invention (i.e., biological agents recognizing normal, benign hyperplastic, and cancerous prostate epithelial cells) are bound. This involves administering the biological agents bonded to a cytotoxic drug to a mammal requiring such treatment. In the case of normal, benign hyperplastic, and cancerous prostate epithelial cells, since the biological agents recognize prostate epithelial cells, any such cells to which the biological agents bind are destroyed. Although such administration may destroy



- 31 -

normal prostate epithelial cells, this is not problematic, because the prostate is not required for life or survival. Although the prostate may indirectly contribute to fertility, this is not likely to be a practical consideration in patients receiving the treatment of the present invention. In the case of cancerous tissues, since the biological agents recognize vascular endothelial cells that are proximate to cancerous cells, binding of the biological agent/cytotoxic drug complex to these vascular endothelial cells destroys them, thereby cutting off the blood flow to the proximate cancerous cells and, thus, killing or ablating these cancerous cells. Alternatively, the biological agents, by virtue of their binding to vascular endothelial cells that are proximate to cancerous cells, are localized proximate to the cancerous cells. Thus, by use of suitable biological agents (including those containing substances effective to kill cells nondiscriminatingly but only over a short range), cells in cancerous tissue (including cancerous cells) can be selectively killed or ablated.

The biological agents of the present invention may be used to deliver a variety of cytotoxic drugs including therapeutic drugs, a compound emitting radiation, molecules of plants, fungal, or bacterial origin, biological proteins, and mixtures thereof. The cytotoxic drugs can be intracellularly acting cytotoxic drugs, such as short-range radiation emitters, including, for example, short-range, high-energy  $\alpha$ -emitters.

Enzymatically active toxins and fragments thereof are exemplified by diphtheria toxin A fragment, nonbinding active fragments of diphtheria toxin, exotoxin A (from *Pseudomonas aeruginosa*), ricin A chain, abrin A chain, modeccin A chain,  $\alpha$ -sacrin, certain *Aleurites fordii* proteins, certain Dianthin proteins, *Phytolacca americana* proteins (PAP, PAPII and PAP-S), *Morodica charantia* inhibitor, curcin, crotin, *Saponaria*

- 32 -

officinalis inhibitor, gelonin, mitogillin, restrictocin, phenomyacin, and enomycin, for example. Procedures for preparing enzymatically active polypeptides of the immunotoxins are described in W084/03508 and W085/03508, which are hereby incorporated by reference. Certain cytotoxic moieties are derived from adriamycin, chlorambucil, daunomycin, methotrexate, neocarzinostatin, and platinum, for example.

Procedures for conjugating the biological agents with the cytotoxic agents have been previously described. Procedures for conjugating chlorambucil with antibodies are described by Flechner, I., European Journal of Cancer, 9:741-745 (1973); Ghose, T. et al., British Medical Journal, 3:495-499 (1972); and Szekerke, M., et al., Neoplasma, 19:211-215 (1972), which are hereby incorporated by reference. Procedures for conjugating daunomycin and adriamycin to antibodies are described by Hurwitz, E. et al., Cancer Research, 35:1175-1181 (1975) and Arnon, R. et al. Cancer Surveys, 1:429-449 (1982), which are hereby incorporated by reference. Procedures for preparing antibody-ricin conjugates are described in U.S. Patent No. 4,414,148 and by Osawa, T., et al. Cancer Surveys, 1:373-388 (1982) and the references cited therein, which are hereby incorporated by reference. Coupling procedures as also described in EP 86309516.2, which is hereby incorporated by reference.

In a particularly preferred embodiment of the present invention, especially well-suited for killing or ablating normal, benign hyperplastic, and cancerous prostate epithelial cells, a first biological agent is conjugated with a prodrug which is activated only when in close proximity with a prodrug activator. The prodrug activator is conjugated with a second biological agent according to the present invention, preferably one which binds to a non-competing site on the prostate specific membrane antigen molecule. Whether two biological agents

- 33 -

bind to competing or non-competing binding sites can be determined by conventional competitive binding assays. For example, monoclonal antibodies J591, J533, and E99 bind to competing binding sites on the prostate specific membrane antigen molecule. Monoclonal antibody J415, on the other hand, binds to a binding site which is non-competing with the site to which J591, J533, and E99 bind. Thus, for example, the first biological agent can be one of J591, J533, and E99, and the second biological agent can be J415. Alternatively, the first biological agent can be J415, and the second biological agent can be one of J591, J533, and E99. Drug-prodrug pairs suitable for use in the practice of the present invention are described in Blakely et al., "ZD2767, an Improved System for Antibody-directed Enzyme Prodrug Therapy That Results in Tumor Regressions in Colorectal Tumor Xenografts," Cancer Research, 56:3287-3292 (1996), which is hereby incorporated by reference.

Alternatively, the biological agent can be coupled to high energy radiation emitters, for example, a radioisotope, such as  $^{131}\text{I}$ , a  $\gamma$ -emitter, which, when localized at the tumor site, results in a killing of several cell diameters. See, e.g., S.E. Order, "Analysis, Results, and Future Prospective of the Therapeutic Use of Radiolabeled Antibody in Cancer Therapy", Monoclonal Antibodies for Cancer Detection and Therapy, R.W. Baldwin et al. (eds.), pp 303-316 (Academic Press 1985), which is hereby incorporated by reference. Other suitable radioisotopes include  $\alpha$ -emitters, such as  $^{212}\text{Bi}$ ,  $^{213}\text{Bi}$ , and  $^{211}\text{At}$ , and  $\beta$ -emitters, such as  $^{186}\text{Re}$  and  $^{90}\text{Y}$ . Radiotherapy is expected to be particularly effective, because prostate epithelial cells and vascular endothelial cells within cancers are relatively radiosensitive.

Where the biological agents are used alone to kill or ablate cancerous cells or prostate epithelial cells, such killing or ablation can be effected by

- 34 -

initiating endogenous host immune functions, such as complement-mediated or antibody-dependent cellular cytotoxicity.

5 The biological agent of the present invention can be used and sold together with equipment, as a kit, to detect the particular label.

Biological agents of the present invention can be used in conjunction with other therapeutic treatment modalities. Such other treatments include surgery, 10 radiation, cryosurgery, thermotherapy, hormone treatment, chemotherapy, vaccines, and other immunotherapies.

Also encompassed by the present invention is a method of killing or ablating which involves using the biological agents for prophylaxis. For example, these 15 materials can be used to prevent or delay development or progression of prostate or other cancers.

Use of the therapeutic methods of the present invention to treat prostate and other cancers has a number of benefits. Since the biological agents 20 according to the present invention only target cancerous cells (such as cells of cancerous tissues containing vascular endothelial cells) and prostate epithelial cells, other tissue is spared. As a result, treatment with such biological agents is safer, particularly for 25 elderly patients. Treatment according to the present invention is expected to be particularly effective, because it directs high levels of biological agents, such as antibodies or binding portions thereof, probes, or ligands, to the bone marrow and lymph nodes where 30 prostate cancer metastases and metastases of many other cancers predominate. Moreover, the methods of the present invention are particularly well-suited for treating prostate cancer, because tumor sites for prostate cancer tend to be small in size and, therefore, 35 easily destroyed by cytotoxic agents. Treatment in accordance with the present invention can be effectively monitored with clinical parameters, such as, in the case

- 35 -

of prostate cancer, serum prostate specific antigen and/or pathological features of a patient's cancer, including stage, Gleason score, extracapsular, seminal, vesicle or perineural invasion, positive margins, involved lymph nodes, etc. Alternatively, these parameters can be used to indicate when such treatment should be employed.

Because the biological agents of the present invention bind to living prostate cells, therapeutic methods for treating prostate cancer using these biological agents are much more effective than those which target lysed prostate cells. For the same reasons, diagnostic and imaging methods which determine the location of living normal, benign hyperplastic, or cancerous prostate epithelial cells (as well as vascular endothelial cells within cancers) are much improved by employing the biological agents of the present invention. In addition, the ability to differentiate between living and dead prostate cells can be advantageous, especially to monitor the effectiveness of a particular treatment regimen.

Hybridomas E99, J415, J533, and J591 have been deposited pursuant to, and in satisfaction of, the requirements of the Budapest Treaty on the International Recognition of the Deposit of Microorganisms for the Purposes of Patent Procedure with the American Type Culture Collection ("A.T.C.C.") at 12301 Parklawn Drive, Rockville, Maryland 20852. Hybridoma E99 was deposited on May 2, 1996, and received A.T.C.C. Designation Number HB-12101. Hybridoma J415 was deposited on May 30, 1996, and received A.T.C.C. Designation Number HB-12109. Hybridomas J533 and J591 were deposited on June 6, 1996, and received A.T.C.C. Designation Numbers HB-12127 and HB-12126, respectively.

The present invention is further illustrated by the following examples.

- 36 -

EXAMPLESExample 1 -- Human Tissues

5        Fresh specimens of benign and malignant tissues were obtained from the Department of Pathology of New York Hospital Cornell University Medical Center ("NYH-CUMC"),

Example 2 -- Tissue Culture

10        Cultured cell lines of human cancers were obtained from the Laboratory of Urological Oncology of NYH-CUMC. The prostate cancer cell lines PC-3 (Mickey, D.D., et al., "Characterization Of A Human Prostate Adenocarcinoma Cell Line (DU145) As A Monolayer Culture  
15        And As A Solid Tumor In Athymic Mice," Prog. Clin. Biol. Res., 37:67-84 (1980), which is hereby incorporated by reference), DU-145 (Mickey, D.D., et al., "Characterization Of A Human Prostate Adenocarcinoma Cell Line (DU145) As A Monolayer Culture And As A Solid Tumor  
20        In Athymic Mice," Prog. Clin. Biol. Res., 37:67-84 (1980), which is hereby incorporated by reference), and LNCaP (Horoszewicz, J.S., et al., "LNCaP Model Of Human Prostatic Carcinoma," Cancer Res., 43:1809-1818 (1983), which is hereby incorporated by reference) were obtained  
25        from the American Type Culture Collection (Rockville, MD.). Hybridomas were initially cloned in RPMI-1640 medium supplemented with 10% FCS, 0.1 mM nonessential amino acids, 2mM L-glutamine, 100 units/ml of penicillin, 100 ug/ml of streptomycin and HAT medium (GIBCO, Grand  
30        Island, NY). Subclones were cultured in the same medium without aminopterin.

Example 3 -- Preparation of Mouse Monoclonal Antibodies

      Female BALB/c mice were immunized  
35        intraperitoneally with LNCaP ( $6 \times 10^6$  cells) three times at 2 week intervals. A final intraperitoneal booster immunization was administered with fresh prostate

- 37 -

epithelial cells which had been grown *in vitro*. Three days later, spleen cells were fused with SP-2 mouse myeloma cells utilizing standard techniques (Ueda, R., et al., "Cell Surface Antigens Of Human Renal Cancer Defined By Mouse Monoclonal Antibodies: Identification Of Tissue-Specific Kidney Glycoproteins," Proc. Natl. Acad. Sci. USA, 78:5122-5126 (1981), which is hereby incorporated by reference). Supernatants of the resulting clones were screened by rosette and complement cytotoxicity assays against viable LNCaP. Clones which were positive by these assays were screened by immunochemistry vs normal kidney, colon, and prostate. Clones which were LNCaP<sup>+</sup>/NmlKid<sup>-</sup>/colon<sup>-</sup>/prostate<sup>-</sup> were selected and subcloned 3 times by limiting dilution. The immunoglobulin class of cultured supernatant from each clone was determined by immunodiffusion using specified rabbit antisera (Calbiochem, San Diego, CA). mAbs were purified using the MAPS-II kit (Bio-Rad, Richmond, CA).

#### 20 Example 4 -- Biotinylation of mAbs

Purified mAbs were dialyzed in 0.1 M NaHCO<sub>3</sub> for 2 hours. One ml of mAb at 1 mg/ml was mixed with 0.1 ml of biotinamidocaproate N-hydroxysuccinamide ester (Sigma) in dimethylsulfoxide (1 mg/ml) and stirred for 4 hours at room temperature. Unbound biotin was removed by dialysis against phosphate buffered saline ("PBS").

#### Example 5 -- Immunohistochemical Staining of Prostate Tissues

30 Cryostat sections of prostate tissues were placed inside rings of Falcon 3034 plate covers (Becton-Dickenson, Lincoln Park, NJ) previously coated with 0.45% gelatin solution as described in Marusich, M.F., "A Rapid Method For Processing Very Large Numbers Of Tissue Sections For Immunohistochemical Hybridoma Screening," J. Immunol. Methods, 111:143-145 (1988), which is hereby incorporated by reference. Plates were stored at -80°C.

- 38 -

Cryostat sections were fixed with 2% paraformaldehyde in PBS for 10 min at room temperature, and, after washing with PBS, endogenous peroxidase activity was blocked by treatment with 0.3% hydrogen peroxide in PBS for 10 min at room temperature. After sections were incubated with 2% BSA in PBS for 20 min, mAbs were added for 60 min at room temperature. Slides were extensively washed with PBS and incubated with peroxidase-conjugated rabbit anti-mouse Ig (DAKO Corp., Santa Barbara, CA) diluted 1:100 in 10% normal human serum in PBS for 60 min at room temperature. After a diaminobenzidine reaction, sections were counterstained with hematoxylin.

#### Example 6 -- Serological Analysis

The anti-mouse immunoglobulin mixed hemadsorption assay was performed as described in Ueda, R., et al., "Cell Surface Antigens Of Human Renal Cancer Defined By Mouse Monoclonal Antibodies: Identification Of Tissue-Specific Kidney Glycoproteins," Proc. Natl. Acad. Sci. USA, 78:5122-5126 (1981), which is hereby incorporated by reference. To prepare the indicator cells, anti-mouse Ig (DAKO Corp.) was conjugated to type O human RBC using 0.01% chromium chloride. Serological assays were performed on cells previously plated in Terasaki plates (Nunc, Denmark). Antibodies were incubated with target cells at room temperature for 1 hour. Target cells were then washed, and indicator cells added for 1 hour.

#### Example 7 -- Immunoprecipitation

LNCaP cells ( $2 \times 10^7$ ) were biotinylated with biotin-NHSS (at final concentration of 5mM) for 30 minutes on ice. After washing, the biotinylated cells were resuspended in 1 ml lysis buffer (20mM Tris/HCl pH 8.0, 1mM EDTA, 1mM PMSF, 1% triton X-100) for 30 min on ice. The suspension was centrifuged at 1500g x 100 min at 4°C, and the supernatant was centrifuged at 12,000 rpm



- 39 -

x 15 min at 4°C. The resulting lysate was preabsorbed with rabbit or goat anti-mouse IgG-coated pansorbin for 1 hour at 4°C. The pre-absorbed lysate was incubated with the mAb overnight at 4°C. Rabbit or goat anti-mouse Ig-coated agarose beads were added for 2 hours at 4°C and then washed. The beads were resuspended in Tris-base/NaCl, added to sample buffer with 2-mercaptoethanol, and boiled for 5 min. After centrifuging, the supernatant was run on an SDS-PAGE 12% gel. The gel was transferred to a nitrocellulose membrane which was blocked and stained with straptavidin-peroxidase. The membrane was developed with diaminobenzidine ("DAB").

Sequential immunoprecipitation was similar except that the lysate was initially pre-cleared with one mAb overnight at 4°C. A second mAb was then used to immunoprecipitate the pre-cleared lysate.

Approximately 2000 clones were screened, of which four clones were selected as described in Example 3, above. After subcloning, supernatants from the 4 hybridomas, E99, J415, J533, and J591, were assayed by immunofluorescence against viable (i.e. unfixed) LNCaP, immunoprecipitation, and sequential immunoprecipitation to confirm reactivity to PSMA.

The immunofluorescence study using the LNCaP target cell (described originally in Horoszewicz, which is hereby incorporated by reference, to make the 7E11 antibody and the prototype cell line for expression for PSMA) shows that E99 antibody binds to and renders viable LNCaP cells immunofluorescent. This is in contrast to the 7E11 antibody, which, as noted originally in Horoszewicz, which is hereby incorporated by reference, gives only poor or no binding to viable LNCaP cells but exhibits strong binding once the cells are fixed (killed).

The reactivities of the four mAbs with normal human tissues were examined immunohistochemically; these results are presented in Table 3.

- 40 -

TABLE 3

Reactivity of mAbs with human normal tissues  
by indirect immunoperoxidase staining

Tissues	E99 ( $\gamma_1$ )	J415 ( $\gamma_1$ )	J533 ( $\gamma_1$ )	J591 ( $\gamma_1$ )
Prostate*	●	●	●	●
Kidney				
Glomerulus	○	○	○	○
Prox. Tubule	■	■	■	■
Ureter	○	○	○	○
Bladder	○	○	○	○
Testis	○	○	○	○
Uterus	○			
Esophagus	○	○	○	○
Small Intestine	○	○	○	○
Stomach	○	○	○	○
Colon	○	○	○	○
Spleen	○	○	○	○
Thyroid	○	○	○	○
Lung	○	○	○	○
Pancreas	○	○	○	○
Liver	○	○	○	○
* BPH	0-3 <sup>+</sup>	0-3 <sup>+</sup>	0-4 <sup>+</sup>	0-4 <sup>+</sup>
* Prostate Cancer	0-3 <sup>+</sup>	0-3 <sup>+</sup>	0-4 <sup>+</sup>	0-4 <sup>+</sup>
* LNCaP (scid)	3 <sup>+</sup>	3 <sup>+</sup>	4 <sup>+</sup>	4 <sup>+</sup>
* LuCaP (scid)	0-2 <sup>+</sup>	0-2 <sup>+</sup>	0-3 <sup>+</sup>	0-3 <sup>+</sup>

● - positive; ■ - weak, heterogeneous; ○ - negative

The above sequential immunoprecipitation study showed that 7E11, E99, J415, J533, and J591 bind to the same molecule, i.e. PSMA.

#### Example 8 -- Western Blot Analysis

To confirm that antibodies E99, J415, J533, and J591 precipitate an identical band to the 7E11 antibody (i.e., PSMA), Western Blot analyses were performed. Seminal plasma (400  $\mu$ g/lane) or LNCaP lysate were loaded into lanes of 12% SDS-PAGE gels. After electrophoresis, the gels are transferred to nitrocellulose membranes. The membranes were blocked with 5% dry milk/Tris-buffered saline-tween 20 ("TBST") for 60 min at room temperature. After washing, the membranes were incubated with primary mAb for 60 min at room temperature. After repeat

- 41 -

washing, the membranes were incubated with sheep anti-mouse-Ig-peroxidase 1/5000 in 5% dry milk/TBST for 60 min at room temperature. After repeat washing, the membranes were developed using a chemiluminescent tag designated "ECL" (Amersham Life Sciences, International, Arlington Heights, Illinois) according to the manufacturer's directions. The results of the Western Blot experiment are presented in Table 4.

TABLE 4  
Western blot data

Sample	7E11	E99	J415	J533	J591
Prostatic	100 KD	100 KD	100 KD	100 KD	100 KD
(seminal)	band	band	band	band	band
fluid					
LNCaP	100 KD &	100 KD &	100 KD &	100 KD &	100 KD &
cell lysate	200 KD	200 KD	200 KD	200 KD	200 KD
	bands	bands	bands	bands	bands

Example 9 -- mAb Reactivity to External Domain of PSMA

To confirm cell surface (external) expression of the detected PSMA, fresh, viable LNCaP cells were tested, without fixation, in vitro, by immunofluorescence. LNCaP cells were washed and incubated with mAb for 1 hour at room temperature and then with a rabbit anti-mouse Ig-fluorescein (DAKO Corp., Santa Barbara, CA). Wells were read with a fluorescent microscope. Negative control consisted of an isotype-matched irrelevant mAb, while an anti-class I MHC mAb served as a positive control.

Immunofluorescence and rosette assay results are presented in Table 5.

- 42 -

TABLE 5

Comparison of 7E11 with new mAbs

5	LNCaP viable cells	7E11	E99	J415	J533	J591
	Immunofluor- escence	neg	3+	3+	4+	4+
10	Rosette assay	neg	+	+	+	+
15	LNCaP-fixed	+++	++++	+++	++	+++

Example 10 -- Competition Studies

A competition study was carried out to determine whether J591, J533, E99, and J415 detected the same or different antigenic sites (epitopes) of the prostate specific membrane antigen molecule using the following procedure.

Plates were coated with LNCaP cell line lysate as a source of prostate specific membrane antigen and washed to remove unbound material. "Cold" (unlabeled) monoclonal antibody was incubated on the plate for 1 hour at room temperature to allow binding to its antigenic site. Subsequently, a second monoclonal antibody, labeled either with biotin or  $^{125}\text{I}$ , was added for an additional hour. Plates were washed to remove unbound material. The amount of the second monoclonal antibody bound to the prostate specific membrane antigen-coated plate was determined either by avidin-alkaline phosphatase in an enzyme-linked immunoassay (in the case of biotin-labeled second monoclonal antibody) or by physically counting the well in a gamma counter (in the case of  $^{125}\text{I}$ -labeled second monoclonal antibody). Controls consisted of using the same monoclonal antibody both cold and labeled to define "100% competition" or using monoclonal antibody to a totally different molecule (e.g., monoclonal antibody I-56, which detects inhibin, a

- 43 -

prostate related protein different from prostate specific membrane antigen) to define "0% competition".

The results indicated that J591, J533, and E99 each interfere, compete, or block binding of one another but do not block binding of J415 and vice versa. 7E11/CYT356, known to bind PSMA at a different (intracellular) site, did not block any of J591, J533, E99, or J415.

Having pairs of monoclonal antibodies which bind to non-competing sites permits development of antibody sandwich assays for detecting soluble antigens, such as solubilized prostate specific membrane antigen or fragment thereof, in, for example, body fluids. For example, the antigen (e.g., prostate specific membrane antigen or a fragment thereof) could be "captured" from body fluid with J591 and, in another step, detected by labeled J415.

In another setting, e.g. treatment, one could increase antibody binding by using a combination of non-competing monoclonal antibodies. For example, assuming the non-competing sites are each represented once on the prostate specific membrane antigen molecule, adding a combination of J591 plus J415 would bind twice as many monoclonal antibody molecules as either monoclonal antibody alone. Binding two non-competing antigenic binding sites also can result in greater antigen cross-linking and, perhaps, increased internalization. Furthermore, since the two detected sites are physically located on the same prostate specific membrane antigen molecule, the binding of two monoclonal antibody molecules to that single prostate specific membrane antigen molecule puts the two monoclonal antibody molecules in close proximity to each other, a setting which provides optimal drug-prodrug interaction. For example, monoclonal antibody J591 can be conjugated with an inactive pro-drug and J415 can be conjugated with a pro-drug activator. Since prodrug and activator would be

- 44 -

bound in close proximity only at the site of prostate specific membrane antigen-expressing cells (e.g., prostate cancer cells), prodrug activation to the active form would occur only at those sites.

5

Example 11 -- Microscopy

Confocal microscopy and immuno-electron microscopy demonstrated that E99, J591, J533, and J415 are bound to the cell membrane at clathrin-coated pits and then rapidly internalize into endosomes (cytoplasmic vesicles). Figures 1-4 are immuno-electron micrographs which follow the interaction of gold-labeled monoclonal antibody J591 with the cell surface as a function of time. In these figures, the location of the monoclonal antibody is indicated by the black dots.

Viable LNCaP cells were incubated with J591 for one hour at 4°C. The cells were washed and then held at 37°C for 0, 5, 10, or 15 minutes, after which time they were fixed and processed for immuno-electron microscopy. Figure 1 shows the cell prior to 37°C incubation. J591 can be seen bound to the cell along the external aspect of the cell membrane. In this Figure, "M" denotes the cell's mitochondria, and "N" denotes its nucleus. Figure 2 shows the cell after incubation at 37°C for 5 minutes. The arrow indicates formation of a clathrin-coated pit. In Figure 3, which shows the cell after a 10 minute 37°C incubation, pinching off or endocytosis of the clathrin-coated pit can be seen, as indicated by the arrow. Figure 4 shows that, after incubation at 37°C for 15 minutes, monoclonal antibody J591 is contained in endocytic vesicles within the cell, as indicated by the arrows. As can be seen in Figure 5, after incubation at 37°C for 15 minutes, monoclonal antibody J591 is also contained within endosomes, as indicated by the arrows.

- 45 -

Example 12 -- Sequencing of the Variable Region of  
Monoclonal Antibody J591

5 Total RNA was prepared from 10<sup>7</sup> murine hybridoma  
J591 cells. A sample of the conditioned medium from  
these cells was tested for binding to the specific  
antigen for J591 on prostate cells. The conditioned  
medium was positive by both ELISA and Western Blot for  
binding to the antigen.

10 VH and VK cDNA were prepared using reverse  
transcriptase and mouse  $\kappa$  constant region and mouse IgG  
constant region primers. The first strand cDNAs were  
amplified by PCR using a variety of mouse signal sequence  
primers (6 for VH and 7 for VK). The amplified DNAs were  
15 gel-purified and cloned into the vector pT7Blue.

The VH and VK clones obtained were screened for  
correct inserts by PCR, and the DNA sequence of selected  
clones was determined by the dideoxy chain termination  
method.

20 Excluding the primer region (as the sequence of  
this depended on the sequence of the primer that was  
used), all the VH clones obtained gave identical  
sequence. This sequence was obtained from clones  
produced with three different 5' primers. One clone had  
25 one base pair change within the signal sequence, and one  
clone contained an aberrant PCR product. Using the  
sequencing strategy shown in Figure 6, the nucleotide  
sequence for the heavy chain was obtained. It is  
designated SEQ. ID. No. 1 and is presented in Figure 7,  
30 along with the nucleotide sequence of the corresponding  
reverse, non-coding strand (designated SEQ. ID. No. 2).  
These sequences include part of the signal sequence and  
part of the constant region of the antibody. The  
corresponding deduced amino acid sequences of J591 VH,  
35 designated SEQ. ID. No. 3, SEQ. ID. No. 4, and SEQ. ID.  
No. 5, are also shown in Figure 7. The coding strand of  
the J591 heavy chain's variable region (exclusive of  
signal sequence and constant region components) has the

- 46 -

following nucleotide sequence (designated SEQ. ID. No. 6):

5 GAGGTCCAGCTGCAACAGTCTGGACCTGAACTGGTGAAGCCTGGGACTTCAGTGAGG  
ATATCCTGCAAGACTTCTGGATACACATTCACTGAATATAACCATACACTGGGTGAAG  
CAGAGCCATGGAAAGAGCCTTGAGTGGATTGGAAACATCAATCCTAACAATGGTGGT  
ACCACCTACAATCAGAAGTTCGAGGACAAGGCCACATTGACTGTAGACAAGTCCTCC  
AGTACAGCCTACATGGAGCTCCGCAGCCTAACATCTGAGGATTCTGCAGTCTATTAT  
TGTGCAGCTGGTTGGAACCTTGACTACTGGGGCCAAGGCACCACTCTCACAGTCTCC  
10 TCA

The reverse, non-coding strand of the J591 heavy chain's  
variable region (exclusive of signal sequence and  
constant region components) has the following nucleotide  
15 sequence (designated SEQ. ID. No. 7):

20 TGAGGAGACTGTGAGAGTGGTGCCTTGGCCCCAGTAGTCAAAGTTCQAACCAGCTGC  
ACAATAATAGACTGCAGAATCCTCAGATGTTAGGCTGCGGAGCTCCATGTAGGCTGT  
ACTGGAGGACTTGTCTACAGTCAATGTGGCCTTGTCCTCGAACTTCTGATTGTAGGT  
GGTACCACCATTTGTTAGGATTGATGTTTCCAATCCACTCAAGGCTCTTTCCATGGCT  
CTGCTTCACCCAGTGTATGGTATATTCAAGTGAATGTGTATCCAGAAGTCTTGCAGGA  
TATCCTCACTGAAGTCCCAGGCTTACCAGTTCAGGTCCAGACTGTTGCAGCTGGAC  
CTC

25 The protein sequence corresponding to the J591 heavy  
chain's variable region (exclusive of signal sequence and  
constant region components) has the following nucleotide  
sequence (designated SEQ. ID. No. 8):

30 EVQLQQSGPELVKPGTQSVRISCKTSGYTFTEYTIHWVKQSHGKSLEWIGNINPNNGG  
TTYNQKFEDKATLTVDKSSSTAYMELRSLTSEDSAVYYCAAGWNFDYWGQGTTLTVS  
S

The J591 VH is in Mouse Heavy Chains Subgroup  
35 IIA (Kabat et al., Sequences of Proteins of Immunological  
Interest, U.S. Department of Health and Human Services  
(1991) ("Kabat"), which is hereby incorporated by



- 47 -

reference). The sequence of J591 VH is compared to the consensus sequence for this subgroup in Figure 8.

In contrast to the VH, more than one VK sequence was obtained. Out of the 15 VK clones examined, 5 four gave the sequence of an aberrant mouse Ig $\kappa$  from the fusion partner (Carol et al., Molecular Immunology, 25:991-995 (1988), which is hereby incorporated by reference). These clones originated from two specific 5' primers. No further work was done with these clones. Of 10 the remaining clones, ten gave identical nucleotide sequences, and one clone, VK17, gave an alternative VK sequence. The ten identical clones originated from three 5' primers (different from the two that gave the aberrant sequence), one of which also produced VK17. The 15 sequencing strategy that was employed is shown in Figure 9.

The nucleic acid sequence of J591 VK corresponding to the ten identical clones (designated SEQ. ID. No. 9) is presented in Figure 10, along with the 20 nucleic acid sequence of the corresponding reverse, non-coding strand (designated SEQ. ID. No. 10) and the deduced amino acid sequences, which are designated SEQ. ID. No. 11, SEQ. ID. No. 12, and SEQ. ID. No. 13. These sequences include part of the signal sequence and part of 25 the constant region of the antibody. The coding strand of the J591 light (kappa) chain's variable region (exclusive of signal sequence and constant region components) corresponding to the ten identical clones has the following nucleotide sequence (designated SEQ. ID. 30 No. 14):

```
AACATTGTAATGACCCAATCTCCCAAATCCATGTCCATGTCAGTAGGAGAGAGGGTC
ACCTTGACCTGCAAGGCCAGTGAGAATGTGGTTACTTATGTTTCCTGGTATCAACAG
AAACCAGAGCAGTCTCCTAAACTGCTGATATACGGGGCATCCAACCGGTACACTGGG
35 GTCCCCGATCGCTTCACAGGCAGTGGATCTGCAACAGATTTCACTCTGACCATCAGC
AGTGTGCAGGCTGAAGACCTTGCAGATTATCACTGTGGACAGGGTTACAGCTATCCG
TACACGTTCCGGAGGGGGGACCAAGCTGGAATAAAA
```

- 48 -

The reverse, non-coding strand of the J591 light (kappa) chain's variable region (exclusive of signal sequence and constant region components) corresponding to the ten identical clones has the following nucleotide sequence  
5 (designated SEQ. ID. No. 15):

TTTTATTTCCAGCTTGGTCCCCCTCCGAACGTGTACGGATAGCTGTAACCCTGTCC  
ACAGTGATAATCTGCAAGGTCTTCAGCCTGCACACTGCTGATGGTCAGAGTGAAATC  
TGTTGCAGATCCACTGCCTGTGAAGCGATCGGGGACCCCAGTGTACCGGTTGGATGC  
10 CCCGTATATCAGCAGTTTAGGAGACTGCTCTGGTTTCTGTTGATACCAGGAAACATA  
AGTAACCACATTCTCACTGGCCTTGCAGGTCAAGGTGACCCTCTCTCCTACTGACAT  
GGACATGGATTTGGGAGATTGGGTCATTACAATGTT

The protein sequence corresponding to the J591 light  
15 (kappa) chain's variable region (exclusive of signal sequence and constant region components) corresponding to the ten identical clones has the following nucleotide sequence (designated SEQ. ID. No. 16):

20 NIVMTQSPKSMMSVGERVTLTCKASENVVTYVSWYQQKPEQSPKLLIYGASNRYTG  
VPDRFTGSGSATDFTLTISSVQAEDLADYHCGQGYSPYPTFGGGTKLEIK

The coding strand of the J591 light (kappa) chain's variable region (exclusive of signal sequence and  
25 constant region components) corresponding to clone VK17 has the following nucleotide sequence (designated SEQ. ID. No. 17):

GACATTGTGATGACCCAGTCTCACAAATTCATGTCCACATCAGTAGGAGACAGGGTC  
30 AGCATCATCTGTAAGGCCAGTCAAGATGTGGGTACTGCTGTAGACTGGTATCAACAG  
AAACCAGGACAATCTCCTAAACTACTGATTTATTGGGCATCCACTCGGCACACTGGA  
GTCCCTGATCGCTTCACAGGCAGTGGATCTGGGACAGACTTCACTCTCACCATTACT  
AATGTTTCAGTCTGAAGACTTGGCAGATTATTTCTGTCAGCAATATAACAGCTATCCT  
CTCACGTTTCGGTGCTGGGACCATGCTGGACCTGAAA

35

The reverse, non-coding strand of the J591 light (kappa) chain's variable region (exclusive of signal sequence and

- 49 -

constant region components) corresponding to clone VK17 has the following nucleotide sequence (designated SEQ. ID. No. 18):

5 TTTTCAGGTCCAGCATGGTCCCAGCACCGAACGTGAGAGGATAGCTGTTATATTGCTG  
ACAGAAATAATCTGCCAAGTCTTCAGACTGAACATTAGTAATGGTGAGAGTGAAGTC  
TGTTCCCAGATCCACTGCCTGTGAAGCGATCAGGGACTCCAGTGTGCCGAGTGGATGC  
CCAATAAATCAGTAGTTTAGGAGATTGTCCTGGTTTCTGTTGATACCACTCTACAGC  
AGTACCCACATCTTGACTGGCCTTACAGATGATGCTGACCCTGTCTCCTACTGATGT  
10 GGACATGAATTTGTGAGACTGGGTCATCACAATGTC

The protein sequence corresponding to the J591 light (kappa) chain's variable region (exclusive of signal sequence and constant region components) corresponding to clone VK17 has the following nucleotide sequence (designated SEQ. ID. No. 19):

DIVMTQSHKFMSTSVGDRVSIICKASQDVGTAVDWYQQKPGQSPKLLIWASTRHTG  
VPDRFTGSGSGTDFTLTITNVQSEDLADYFCQQYNSYPLTFGAGTMLDLK  
20

J591 VK is in the Mouse Kappa Chains Subgroup V (Kabat, which is hereby incorporated by reference). The sequence of J591 VK corresponding to the ten identical clones is compared to the consensus sequence for the subgroup in Figure 11.

Preferred J591's are those having heavy chain variable region DNA coding strand sequences corresponding to SEQ. ID. No. 6 and non-coding strand (reverse) sequences corresponding to SEQ. ID. No. 7. The heavy chain variable region of J591 preferably has an amino acid sequence corresponding to SEQ. ID. No. 8. The light chain variable region of J591 preferably has a DNA coding strand sequence corresponding to SEQ. ID. No. 17, a DNA non-coding strand (reverse) sequence corresponding to SEQ. ID. No. 18, and a amino acid sequence corresponding to SEQ. ID. No. 19.

- 50 -

Example 13 -- Immunohistochemical Staining of Normal and Cancer Tissues

Cancer tissues from 23 carcinomas were pre-cooled in liquid nitrogen, snap-frozen in OCT compound (Miles, Elkhart, Indiana) on dry ice, and stored at -80°C. Cryostat tissue sections (5µm) were fixed in cold acetone (4°C) for 10 minutes. mAbs (5 µg/ml or hybridoma supernatants) were incubated for 1 hour at room temperature. Antibody binding was detected using rabbit anti-mouse Ig-peroxidase (Dako, Carpinteria, California) as a secondary antibody and DAB (Sigma, St. Louis, Missouri) as chromogen. Isotype-matched irrelevant antibody was used as negative control.

mAbs J591, J533, J415, and E99 reacted strongly with vascular endothelia in all 23 carcinomas studied, including 9/9 renal, 5/5 urothelial, 6/6 colon, 1/1 lung, and 1/1 breast carcinomas, and 1/1 metastatic adenocarcinoma to the liver. Figures 2A-2F, respectively, show the immunohistochemical reactivity of mAb J591 to neovasculature of renal, urothelial, colon, lung, and breast carcinomas, and metastatic adenocarcinoma to the liver.

Although the invention has been described in detail for the purpose of illustration, it is understood that such detail is solely for that purpose and variations can be made by those skilled in the art without departing from the spirit and scope of the invention which is defined by the following claims.

- 51 -

## SEQUENCE LISTING

## (1) GENERAL INFORMATION:

- (i) APPLICANT: Cornell Research Foundation, Inc.
- (ii) TITLE OF INVENTION: TREATMENT AND DIAGNOSIS OF  
CANCER
- (iii) NUMBER OF SEQUENCES: 19
- (iv) CORRESPONDENCE ADDRESS:
  - (A) ADDRESSEE: Nixon, Hargrave, Devans & Doyle LLP
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  - (C) CITY: Rochester
  - (D) STATE: New York
  - (E) COUNTRY: U.S.A.
  - (F) ZIP: 14603-1051
- (v) COMPUTER READABLE FORM:
  - (A) MEDIUM TYPE: Floppy disk
  - (B) COMPUTER: IBM PC compatible
  - (C) OPERATING SYSTEM: PC-DOS/MS-DOS
  - (D) SOFTWARE: PatentIn Release #1.0, Version #1.30
- (vi) CURRENT APPLICATION DATA:
  - (A) APPLICATION NUMBER:
  - (B) FILING DATE:
  - (C) CLASSIFICATION:
- (vii) PRIOR APPLICATION DATA:
  - (A) APPLICATION NUMBER: US 06/022,125
  - (B) FILING DATE: 18-JUL-1996
- (vii) PRIOR APPLICATION DATA:
  - (A) APPLICATION NUMBER: US 08/838,632
  - (B) FILING DATE: 09-APR-1997
- (viii) ATTORNEY/AGENT INFORMATION:
  - (A) NAME: Goldman, Michael L.
  - (B) REGISTRATION NUMBER: 30,727
  - (C) REFERENCE/DOCKET NUMBER: 19603/1174
- (ix) TELECOMMUNICATION INFORMATION:
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## (2) INFORMATION FOR SEQ ID NO:1:

- (i) SEQUENCE CHARACTERISTICS:

- 52 -

- (A) LENGTH: 391 base pairs
- (B) TYPE: nucleic acid
- (C) STRANDEDNESS: single
- (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: cDNA

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:1:

TCTCCTGTCA	GGAAGTGCAG	GTGTCCTCTC	TGAGGTCCAG	CTGCAACAGT	CTGGACCTGA	60
ACTGGTGAAG	CCTGGGACTT	CAGTGAGGAT	ATCCTGCAAG	ACTTCTGGAT	ACACATTAC	120
TGAATATACC	ATACACTGGG	TGAAGCAGAG	CCATGGAAAG	AGCCTTGAGT	GGATTGGAAA	180
CATCAATCCT	AACAATGGTG	GTACCACCTA	CAATCAGAAG	TTGAGGACA	AGGCCACATT	240
GACTGTAGAC	AAGTCTCCA	GTACAGCCTA	CATGGAGCTC	CGCAGCCTAA	CATCTGAGGA	300
TTCTGCAGTC	TATTATTGTG	CAGCTGGTTG	GAACCTTGAC	TACTGGGGCC	AAGGCACCAC	360
TCTCACAGTC	TCCTCAGCCA	AAACGACACC	C			391

(2) INFORMATION FOR SEQ ID NO:2:

- (i) SEQUENCE CHARACTERISTICS:
  - (A) LENGTH: 391 base pairs
  - (B) TYPE: nucleic acid
  - (C) STRANDEDNESS: single
  - (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: cDNA

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:2:

GGGTGTCGTT	TTGGCTGAGG	AGACTGTGAG	AGTGGTGCCT	TGGCCCCAGT	AGTCAAAGTT	60
CCAACCAGCT	GCACAATAAT	AGACTGCAGA	ATCCTCAGAT	GTTAGGCTGC	GGAGCTCCAT	120
GTAGGCTGTA	CTGGAGGACT	TGTCTACAGT	CAATGTGGCC	TTGTCCTCGA	ACTTCTGATT	180
GTAGGTGGTA	CCACCATTGT	TAGGATTGAT	GTTTCCAATC	CACTCAAGGC	TCTTTCCATG	240
GCTCTGCTTC	ACCCAGTGTA	TGGTATATTC	AGTGAATGTG	TATCCAGAAG	TCTTGACAGGA	300
TATCCTCACT	GAAGTCCCAG	GCTTCACCAG	TTCAGGTCCA	GACTGTTGCA	GCTGGACCTC	360
AGAGAGGACA	CCTGCAGTTC	CTAGCAGGAG	A			391

(2) INFORMATION FOR SEQ ID NO:3:

- (i) SEQUENCE CHARACTERISTICS:
  - (A) LENGTH: 123 amino acids
  - (B) TYPE: amino acid
  - (C) STRANDEDNESS:
  - (D) TOPOLOGY: linear

- 53 -

(ii) MOLECULE TYPE: protein

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:3:

```

Ser Pro Val Arg Asn Cys Arg Cys Pro Leu Gly Pro Ala Ala Thr Val
1      5      10      15
Trp Thr Thr Gly Glu Ala Trp Asp Phe Ser Glu Asp Ile Leu Gln Asp
20      25      30
Phe Trp Ile His Ile His Ile Tyr His Thr Leu Gly Glu Ala Glu Pro
35      40      45
Trp Lys Glu Pro Val Asp Trp Lys His Gln Ser Gln Trp Trp Tyr His
50      55      60
Leu Gln Ser Glu Val Arg Gly Gln Gly His Ile Asp Cys Arg Gln Val
65      70      75      80
Leu Gln Tyr Ser Leu His Gly Ala Pro Gln Pro Asn Ile Gly Phe Cys
85      90      95
Ser Leu Leu Leu Cys Ser Trp Leu Glu Leu Leu Leu Gly Pro Arg His
100     105     110
His Ser His Ser Leu Leu Ser Gln Asn Asp Thr
115     120

```

(2) INFORMATION FOR SEQ ID NO:4:

- (i) SEQUENCE CHARACTERISTICS:
- (A) LENGTH: 130 amino acids
  - (B) TYPE: amino acid
  - (C) STRANDEDNESS:
  - (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: protein

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:4:

```

Leu Leu Ser Gly Thr Ala Gly Val Leu Ser Glu Val Gln Leu Gln Gln
1      5      10      15
Ser Gly Pro Glu Leu Val Lys Pro Gly Thr Ser Val Arg Ile Ser Cys
20      25      30
Lys Thr Ser Gly Tyr Thr Phe Thr Glu Tyr Thr Ile His Trp Val Lys
35      40      45
Gln Ser His Gly Lys Ser Leu Glu Trp Ile Gly Asn Ile Asn Pro Asn
50      55      60
Asn Gly Gly Thr Thr Tyr Asn Gln Lys Phe Glu Asp Lys Ala Thr Leu
65      70      75      80
Thr Val Asp Lys Ser Ser Ser Thr Ala Tyr Met Glu Leu Arg Ser Leu
85      90      95
Thr Ser Glu Asp Ser Ala Val Tyr Tyr Cys Ala Ala Gly Trp Asn Phe
100     105     110

```

- 54 -

Asp Tyr Trp Gly Gln Gly Thr Thr Leu Thr Val Ser Ser Ala Lys Thr  
 115 120 125  
 Thr Pro  
 130

## (2) INFORMATION FOR SEQ ID NO:5:

- (i) SEQUENCE CHARACTERISTICS:  
 (A) LENGTH: 125 amino acids  
 (B) TYPE: amino acid  
 (C) STRANDEDNESS:  
 (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: protein

## (xi) SEQUENCE DESCRIPTION: SEQ ID NO:5:

Leu Ser Cys Gln Glu Leu Gln Val Ser Ser Leu Arg Ser Ser Cys Asn  
 1 5 10 15  
 Ser Leu Asp Leu Asn Trp Ser Leu Gly Leu Gln Gly Tyr Pro Ala Arg  
 20 25 30  
 Leu Leu Asp Thr His Ser Leu Asn Ile Pro Tyr Thr Gly Ser Arg Ala  
 35 40 45  
 Met Glu Arg Ala Leu Ser Gly Leu Glu Thr Ser Ile Leu Thr Met Val  
 50 55 60  
 Val Pro Pro Thr Ile Arg Ser Ser Arg Thr Arg Pro His Leu Thr Ser  
 65 70 75 80  
 Pro Pro Val Gln Pro Thr Trp Ser Ser Ala Ala His Leu Arg Ile Leu  
 85 90 95  
 Gln Ser Ile Ile Val Gln Leu Val Gly Thr Leu Thr Thr Gly Ala Lys  
 100 105 110  
 Ala Pro Leu Ser Gln Pro Ser Gln Pro Lys Arg His Pro  
 115 120 125

## (2) INFORMATION FOR SEQ ID NO:6:

- (i) SEQUENCE CHARACTERISTICS:  
 (A) LENGTH: 345 base pairs  
 (B) TYPE: nucleic acid  
 (C) STRANDEDNESS: single  
 (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: cDNA

## (xi) SEQUENCE DESCRIPTION: SEQ ID NO:6:

GAGGTCCAGC TGCAACAGTC TGGACCTGAA CTGGTGAAGC CTGGGACTTC AGTGAGGATA 60  
 TCCTGCAAGA CTTCTGGATA CACATTCACT GAATATACCA TAACTGGGT GAAGCAGAGC 120



- 55 -

CATGGAAAGA GCCTTGAGTG GATTGGAAAC ATCAATCCTA ACAATGGTGG TACCACCTAC	180
AATCAGAAGT TCGAGGACAA GGCCACATTG ACTGTAGACA AGTCCTCCAG TACAGCCTAC	240
ATGGAGCTCC GCAGCCTAAC ATCTGAGGAT TCTGCAGTCT ATTATTGTGC AGCTGGTTGG	300
AACTTTGACT ACTGGGGCCA AGGCACCACT CTCACAGTCT CCTCA	345

## (2) INFORMATION FOR SEQ ID NO:7:

- (i) SEQUENCE CHARACTERISTICS:
- (A) LENGTH: 345 base pairs
  - (B) TYPE: nucleic acid
  - (C) STRANDEDNESS: single
  - (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: cDNA

## (xi) SEQUENCE DESCRIPTION: SEQ ID NO:7:

TGAGGAGACT GTGAGAGTGG TGCCTTGGCC CCAGTAGTCA AAGTTCCAAC CAGCTGCACA	60
ATAATAGACT GCAGAATCCT CAGATGTTAG GCTGCGGAGC TCCATGTAGG CTGTACTGGA	120
GGACTTGTCT ACAGTCAATG TGGCCTTGTC CTCGAACTTC TGATTGTAGG TGGTACCACC	180
ATTGTTAGGA TTGATGTTTC CAATCCACTC AAGGCTCTTT CCATGGCTCT GCTTCACCCA	240
GTGTATGGTA TATTCAGTGA ATGTGTATCC AGAAGTCTTG CAGGATATCC TCACTGAAGT	300
CCCAGGCTTC ACCAGTTCAG GTCCAGACTG TTGCAGCTGG ACCTC	345

## (2) INFORMATION FOR SEQ ID NO:8:

- (i) SEQUENCE CHARACTERISTICS:
- (A) LENGTH: 115 amino acids
  - (B) TYPE: amino acid
  - (C) STRANDEDNESS:
  - (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: protein

## (xi) SEQUENCE DESCRIPTION: SEQ ID NO:8:

Glu Val Gln Leu Gln Gln Ser Gly Pro Glu Leu Val Lys Pro Gly Thr	1	5	10	15
Ser Val Arg Ile Ser Cys Lys Thr Ser Gly Tyr Thr Phe Thr Glu Tyr	20	25	30	
Thr Ile His Trp Val Lys Gln Ser His Gly Lys Ser Leu Glu Trp Ile	35	40	45	
Gly Asn Ile Asn Pro Asn Asn Gly Gly Thr Thr Tyr Asn Gln Lys Phe	50	55	60	

- 56 -

Glu Asp Lys Ala Thr Leu Thr Val Asp Lys Ser Ser Ser Thr Ala Tyr  
 65 70 75 80  
 Met Glu Leu Arg Ser Leu Thr Ser Glu Asp Ser Ala Val Tyr Tyr Cys  
 85 90 95  
 Ala Ala Gly Trp Asn Phe Asp Tyr Trp Gly Gln Gly Thr Thr Leu Thr  
 100 105 110  
 Val Ser Ser  
 115

## (2) INFORMATION FOR SEQ ID NO:9:

- (i) SEQUENCE CHARACTERISTICS:  
 (A) LENGTH: 363 base pairs  
 (B) TYPE: nucleic acid  
 (C) STRANDEDNESS: single  
 (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: cDNA

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:9:

TTATATGGAG CTGATGGGAA CATTGTAATG ACCCAATCTC CCAAATCCAT GTCCATGTCA	60
GTAGGAGAGA GGGTCACCTT GACCTGCAAG GCCAGTGAGA ATGTGGTTAC TTATGTTTCC	120
TGGTATCAAC AGAAACCAGA GCAGTCTCCT AAAGTCTGTA TATACGGGGC ATCCAACCGG	180
TACACTGGGG TCCCCGATCG CTTACAGGC AGTGGATCTG CAACAGATTT CACTCTGACC	240
ATCAGCAGTG TGCAGGCTGA AGACCTTGCA GATTATCACT GTGGACAGGG TTACAGCTAT	300
CCGTACACGT TCGGAGGGGG GACCAAGCTG GAAATAAAAC GGGCTGATGC TGCACCAACT	360
GTA	363

## (2) INFORMATION FOR SEQ ID NO:10:

- (i) SEQUENCE CHARACTERISTICS:  
 (A) LENGTH: 363 base pairs  
 (B) TYPE: nucleic acid  
 (C) STRANDEDNESS: single  
 (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: cDNA

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:10:

TACAGTTGGT GCAGCATCAG CCCGTTTTAT TTCCAGCTTG GTCCCCCTC CGAACGTGTA	60
CGGATAGCTG TAACCCTGTC CACAGTGATA ATCTGCAAGG TCTTCAGCCT GCACACTGCT	120
GATGGTCAGA GTGAAATCTG TTGCAGATCC ACTGCCTGTG AAGCGATCGG GGACCCAGT	180

- 57 -

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GTACCGGTTG GATGCCCCGT ATATCAGCAG TTTAGGAGAC TGCTCTGGTT TCTGTTGATA      240
CCAGGAAACA TAAGTAACCA CATTCTCACT GGCCTTGACG GTCAAGGTGA CCCTCTCTCC      300
TACTGACATG GACATGGATT TGGGAGATTG GGTCAATTACA ATGTTCCCAT CAGCTCCATA      360
TAA                                                                    363

```

## (2) INFORMATION FOR SEQ ID NO:11:

- (i) SEQUENCE CHARACTERISTICS:
- (A) LENGTH: 121 amino acids
  - (B) TYPE: amino acid
  - (C) STRANDEDNESS:
  - (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: protein

## (xi) SEQUENCE DESCRIPTION: SEQ ID NO:11:

```

Leu Tyr Gly Ala Asp Gly Asn Ile Val Met Thr Gln Ser Pro Lys Ser
1           5           10           15
Met Ser Met Ser Val Gly Glu Arg Val Thr Leu Thr Cys Lys Ala Ser
20          25          30
Glu Asn Val Val Thr Tyr Val Ser Trp Tyr Gln Gln Lys Pro Glu Gln
35          40          45
Ser Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Arg Tyr Thr Gly Val
50          55          60
Pro Asp Arg Phe Thr Gly Ser Gly Ser Ala Thr Asp Phe Thr Leu Thr
65          70          75          80
Ile Ser Ser Val Gln Ala Glu Asp Leu Ala Asp Tyr His Cys Gly Gln
85          90          95
Gly Tyr Ser Tyr Pro Tyr Thr Phe Gly Gly Gly Thr Lys Leu Glu Ile
100         105         110
Lys Arg Ala Asp Ala Ala Pro Thr Val
115         120

```

## (2) INFORMATION FOR SEQ ID NO:12:

- (i) SEQUENCE CHARACTERISTICS:
- (A) LENGTH: 114 amino acids
  - (B) TYPE: amino acid
  - (C) STRANDEDNESS:
  - (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: protein

## (xi) SEQUENCE DESCRIPTION: SEQ ID NO:12:

```

Tyr Met Glu Leu Met Gly Thr Leu Pro Asn Leu Pro Asn Pro Cys Pro
1           5           10           15

```

- 58 -

Cys Gln Glu Arg Gly Ser Pro Pro Ala Arg Pro Val Arg Met Trp Leu  
                   20                                  25                                  30  
 Leu Met Phe Pro Gly Ile Asn Arg Asn Gln Ser Ser Leu Leu Asn Cys  
                   35                                  40                                  45  
 Tyr Thr Gly His Pro Thr Gly Thr Leu Gly Ser Pro Ile Ala Ser Gln  
                   50                                  55                                  60  
 Ala Val Asp Leu Gln Gln Ile Ser Leu Pro Ser Ala Val Cys Arg Leu  
                   65                                  70                                  75                                  80  
 Lys Thr Leu Gln Ile Ile Thr Val Asp Arg Val Thr Ala Ile Arg Thr  
                                   85                                  90                                  95  
 Arg Ser Glu Gly Gly Pro Ser Trp Lys Asn Gly Leu Met Leu His Gln  
                   100                                  105                                  110  
 Leu Tyr

## (2) INFORMATION FOR SEQ ID NO:13:

## (i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 116 amino acids
- (B) TYPE: amino acid
- (C) STRANDEDNESS:
- (D) TOPOLOGY: linear

## (ii) MOLECULE TYPE: protein

## (xi) SEQUENCE DESCRIPTION: SEQ ID NO:13:

Ile Ile Trp Ser Trp Glu His Cys Asn Asp Pro Ile Ser Gln Ile His  
 1                                  5                                  10                                  15  
 Val His Val Ser Arg Arg Glu Gly His Leu Asp Leu Gln Gly Gln Glu  
                   20                                  25                                  30  
 Cys Gly Tyr Leu Cys Phe Leu Val Ser Thr Glu Thr Arg Ala Val Ser  
                   35                                  40                                  45  
 Thr Ala Asp Ile Arg Gly Ile Gln Pro Val His Trp Gly Pro Arg Ser  
                   50                                  55                                  60  
 Leu His Arg Gln Trp Ile Cys Asn Arg Phe His Ser Asp His Gln Gln  
                   65                                  70                                  75                                  80  
 Cys Ala Gly Arg Pro Cys Arg Leu Ser Leu Trp Thr Gly Leu Gln Leu  
                                   85                                  90                                  95  
 Ser Val His Val Arg Arg Gly Asp Gln Ala Gly Asn Lys Thr Gly Cys  
                   100                                  105                                  110  
 Cys Thr Asn Cys  
                   115

## (2) INFORMATION FOR SEQ ID NO:14:

## (i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 321 base pairs

- 59 -

- (B) TYPE: nucleic acid
- (C) STRANDEDNESS: single
- (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: cDNA

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:14:

AACATTGTAA TGACCCAATC TCCCAAATCC ATGTCCATGT CAGTAGGAGA GAGGGTCACC	60
TTGACCTGCA AGGCCAGTGA GAATGTGGTT ACTTATGTTT CCTGGTATCA ACAGAAACCA	120
GAGCAGTCTC CTAAACTGCT GATATACGGG GCATCCAACC GGTACACTGG GGTCCCCGAT	180
CGCTTCACAG GCAGTGGATC TGCAACAGAT TTCACTCTGA CCATCAGCAG TGTGCAGGCT	240
GAAGACCTTG CAGATTATCA CTGTGGACAG GGTACAGCT ATCCGTACAC GTTCGGAGGG	300
GGGACCAAGC TGGAAATAAA A	321

(2) INFORMATION FOR SEQ ID NO:15:

- (i) SEQUENCE CHARACTERISTICS:
  - (A) LENGTH: 321 base pairs
  - (B) TYPE: nucleic acid
  - (C) STRANDEDNESS: single
  - (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: cDNA

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:15:

TTTTATTTC AGCTTGGTCC CCCCTCCGAA CGTGACGGA TAGCTGTAAC CCTGTCCACA	60
GTGATAATCT GCAAGGTCTT CAGCCTGCAC ACTGCTGATG GTCAGAGTGA AATCTGTTGC	120
AGATCCACTG CCTGTGAAGC GATCGGGGAC CCCAGTGTAC CGGTTGGATG CCCC GTATAT	180
CAGCAGTTTA GGAGACTGCT CTGGTTTCTG TTGATACCAG GAAACATAAG TAACCACATT	240
CTCACTGGCC TTGCAGGTCA AGGTGACCCT CTCTCCTACT GACATGGACA TGGATTTGGG	300
AGATTGGGTC ATTACAATGT T	321

(2) INFORMATION FOR SEQ ID NO:16:

- (i) SEQUENCE CHARACTERISTICS:
  - (A) LENGTH: 107 amino acids
  - (B) TYPE: amino acid
  - (C) STRANDEDNESS:
  - (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: protein

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:16:

- 60 -

Asn Ile Val Met Thr Gln Ser Pro Lys Ser Met Ser Met Ser Val Gly  
 1 5 10 15  
 Glu Arg Val Thr Leu Thr Cys Lys Ala Ser Glu Asn Val Val Thr Tyr  
 20 25 30  
 Val Ser Trp Tyr Gln Gln Lys Pro Glu Gln Ser Pro Lys Leu Leu Ile  
 35 40 45  
 Tyr Gly Ala Ser Asn Arg Tyr Thr Gly Val Pro Asp Arg Phe Thr Gly  
 50 55 60  
 Ser Gly Ser Ala Thr Asp Phe Thr Leu Thr Ile Ser Ser Val Gln Ala  
 65 70 75 80  
 Glu Asp Leu Ala Asp Tyr His Cys Gly Gln Gly Tyr Ser Tyr Pro Tyr  
 85 90 95  
 Thr Phe Gly Gly Gly Thr Lys Leu Glu Ile Lys  
 100 105

## (2) INFORMATION FOR SEQ ID NO:17:

## (i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 321 base pairs
- (B) TYPE: nucleic acid
- (C) STRANDEDNESS: single
- (D) TOPOLOGY: linear

## (ii) MOLECULE TYPE: cDNA

## (xi) SEQUENCE DESCRIPTION: SEQ ID NO:17:

GACATTGTGA TGACCCAGTC TCACAAATTC ATGTCCACAT CAGTAGGAGA CAGGGTCAGC	60
ATCATCTGTA AGGCCAGTCA AGATGTGGGT ACTGCTGTAG ACTGGTATCA ACAGAAACCA	120
GGACAATCTC CTAAACTACT GATTATTGG GCATCCACTC GGCACACTGG AGTCCCTGAT	180
CGCTTCACAG GCAGTGGATC TGGGACAGAC TTCACTCTCA CCATTACTAA TGTTCACTCT	240
GAAGACTTGG CAGATTATTT CTGTCAGCAA TATAACAGCT ATCCTCTCAC GTTCGGTGCT	300
GGGACCATGC TGGACCTGAA A	321

## (2) INFORMATION FOR SEQ ID NO:18:

## (i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 321 base pairs
- (B) TYPE: nucleic acid
- (C) STRANDEDNESS: single
- (D) TOPOLOGY: linear

## (ii) MOLECULE TYPE: cDNA

## (xi) SEQUENCE DESCRIPTION: SEQ ID NO:18:

- 61 -

TTTCAGGTCC AGCATGGTCC CAGCACCGAA CGTGAGAGGA TAGCTGTTAT ATTGCTGACA	60
GAAATAATCT GCCAAGTCTT CAGACTGAAC ATTAGTAATG GTGAGAGTGA AGTCTGTCCC	120
AGATCCACTG CCTGTGAAGC GATCAGGGAC TCCAGTGTGC CGAGTGGATG CCCAATAAAAT	180
CAGTAGTTTA GGAGATTGTC CTGGTTTCTG TTGATACCAG TCTACAGCAG TACCCACATC	240
TTGACTGGCC TTACAGATGA TGCTGACCCT GTCTCCTACT GATGTGGACA TGAATTTGTG	300
AGACTGGGTC ATCACAATGT C	321

## (2) INFORMATION FOR SEQ ID NO:19:

## (i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 107 amino acids
- (B) TYPE: amino acid
- (C) STRANDEDNESS:
- (D) TOPOLOGY: linear

## (ii) MOLECULE TYPE: protein

## (xi) SEQUENCE DESCRIPTION: SEQ ID NO:19:

Asp	Ile	Val	Met	Thr	Gln	Ser	His	Lys	Phe	Met	Ser	Thr	Ser	Val	Gly
1				5					10				15		
Asp	Arg	Val	Ser	Ile	Ile	Cys	Lys	Ala	Ser	Gln	Asp	Val	Gly	Thr	Ala
		20						25				30			
Val	Asp	Trp	Tyr	Gln	Gln	Lys	Pro	Gly	Gln	Ser	Pro	Lys	Leu	Leu	Ile
		35				40						45			
Tyr	Trp	Ala	Ser	Thr	Arg	His	Thr	Gly	Val	Pro	Asp	Arg	Phe	Thr	Gly
	50					55					60				
Ser	Gly	Ser	Gly	Thr	Asp	Phe	Thr	Leu	Thr	Ile	Thr	Asn	Val	Gln	Ser
65					70					75				80	
Glu	Asp	Leu	Ala	Asp	Tyr	Phe	Cys	Gln	Gln	Tyr	Asn	Ser	Tyr	Pro	Leu
			85						90					95	
Thr	Phe	Gly	Ala	Gly	Thr	Met	Leu	Asp	Leu	Lys					
			100						105						

- 62 -

## WHAT IS CLAIMED:

1. A method of ablating or killing cancerous cells comprising:
  - 5 providing a biological agent which, when contacted with an extracellular domain of prostate specific membrane antigen, binds to the extracellular domain of prostate specific membrane antigen and contacting vascular endothelial cells proximate
  - 10 to the cancerous cells with the biological agent under conditions effective to permit both binding of the biological agent to the vascular endothelial cells proximate to the cancerous cells and ablating or killing of the cancerous cells.
  - 15
2. A method according to claim 1, wherein the biological agent kills or ablates the vascular endothelial cells proximate to the cancerous cells, thereby killing or ablating the cancerous cells by
- 20 reducing blood flow thereto.
3. A method according to claim 1, wherein the cancerous cells are renal cancerous cells, urothelial cancerous cells, colon cancerous cells, rectal cancerous
- 25 cells, lung cancerous cells, breast cancerous cells, or cancerous cells of metastatic adenocarcinoma to the liver.
4. A method according to claim 1, wherein the
- 30 biological agent is an antibody or binding portion thereof, probe, or ligand.
5. A method according to claim 1, wherein the biological agent, when contacted with an extracellular
- 35 domain of prostate specific membrane antigen, is internalized with the prostate specific membrane antigen.



- 63 -

6. A method according to claim 1, wherein said contacting is carried out in a living mammal and comprises:

5 administering the biological agent to the mammal under conditions effective to permit both binding of the biological agent to vascular endothelial cells proximate to the cancerous cells and killing of the cancerous cells.

10 7. A method according to claim 6, wherein said administering is carried out orally, parenterally, subcutaneously, intravenously, intramuscularly, intraperitoneally, by intranasal instillation, by intracavitary or intravesical instillation,  
15 intraocularly, intraarterially, intralesionally, or by application to mucous membranes.

8. A method according to claim 4, wherein an antibody is used in carrying out said method, the  
20 antibody being selected from the group consisting of a monoclonal antibody and a polyclonal antibody.

9. A method according to claim 8, wherein the antibody is selected from the group consisting of an E99,  
25 a J415, a J533, and a J591 monoclonal antibody.

10. A method according to claim 8, wherein the antibody is a monoclonal antibody produced by a hybridoma cell line having an ATCC Accession Number selected from  
30 the group consisting of HB-12101, HB-12109, HB-12127, and HB-12126.

11. A method according to claim 4, wherein a binding portion of an antibody is used in carrying out  
35 said method, the binding portion being selected from the group consisting of an Fab fragment, an F(ab')<sub>2</sub> fragment, and an Fv fragment.

- 64 -

12. A method according to claim 4, wherein the probe or ligand is used in carrying out said method.

13. A method according to claim 1, wherein the biological agent is bound to a substance effective to kill or ablate the cancerous cells upon binding of the biological agent to vascular endothelial cells proximate to the cancerous cells.

14. A method according to claim 13, wherein the substance effective to kill or ablate the cancerous cells is a cytotoxic drug.

15. A method according to claim 14, wherein the cytotoxic drug is selected from the group consisting of therapeutic drug, a compound emitting radiation, molecules of plant, fungal, or bacterial origin, biological proteins, and mixtures thereof.

16. A method according to claim 4, wherein the antibody is effective to initiate an endogenous host immune function.

17. A method according to claim 16, wherein the endogenous host immune function is complement-mediated cellular cytotoxicity.

18. A method according to claim 16, wherein the endogenous host immune function is antibody-dependent cellular cytotoxicity.

19. A method according to claim 1, wherein the biological agent is in a composition further comprising a physiologically acceptable carrier, excipient, or stabilizer.

- 65 -

20. A method according to claim 1, wherein the biological agent is in a composition further comprising a pharmaceutically acceptable carrier, excipient, or stabilizer.

5

21. A method of detecting cancerous tissue in a biological sample comprising:

providing an biological agent which, when contacted with an extracellular domain of prostate specific membrane antigen, binds to the extracellular domain of prostate specific membrane antigen, wherein the biological agent is bound to a label effective to permit detection of vascular endothelial cells proximate to or within the cancerous tissue upon binding of the biological agent to the vascular endothelial cells proximate to or within the cancerous tissue;

contacting the biological sample with the biological agent having a label under conditions effective to permit binding of the biological agent to the vascular endothelial cells proximate to or within the cancerous tissue in the biological sample; and

detecting a presence of any cancerous tissue in the biological sample by detecting the label.

22. A method according to claim 21, wherein the cancerous tissue is renal cancerous tissue, urothelial cancerous tissue, colon cancerous tissue, rectal cancerous tissue, lung cancerous tissue, breast cancerous tissue, or cancerous tissue of metastatic adenocarcinoma to the liver.

23. A method according to claim 21, wherein the biological agent is an antibody or binding portion thereof, probe, or ligand.

35

24. A method according to claim 21, wherein the biological agent, when contacted with an

- 66 -

extracellular domain of prostate specific membrane antigen, is internalized with the prostate specific membrane antigen.

5                   25. A method according to claim 21, wherein said contacting is carried out in a living mammal and comprises:

                  administering the biological agent to the mammal under conditions effective to permit binding of  
10 the biological agent to the vascular endothelial cells proximate to or within the cancerous tissue in the biological sample.

                  26. A method according to claim 25, wherein  
15 the label is a short-range radiation emitter.

                  27. A method according to claim 25, wherein said administering is carried out orally, parenterally, subcutaneously, intravenously, intramuscularly,  
20 intraperitoneally, by intraversal instillation, by intracavitary or intravesical instillation, intraocularly, intraarterially, intralesionally, or by application to mucous membranes.

25                   28. A method according to claim 23, wherein an antibody is used in carrying out said method, said antibody being selected from the group consisting of a monoclonal antibody and a polyclonal antibody.

30                   29. A method according to claim 28, wherein the antibody is selected from the group consisting of an E99, a J415, a J533, and a J591 monoclonal antibody.

                  30. A method according to claim 28, wherein  
35 the antibody is a monoclonal antibody produced by a hybridoma cell line having an ATCC Accession Number

- 67 -

selected from the group consisting of HB-12101, HB-12109, HB-12127, and HB-12126.

31. A method according to claim 23, wherein a  
5 binding portion of an antibody is used in carrying out said method, the binding portion being selected from the group consisting of an Fab fragment, an F(ab')<sub>2</sub> fragment, and an Fv fragment.

10 32. A method according to claim 23, wherein a probe or ligand is used in carrying out said method.

33. A method according to claim 21, wherein  
the label is selected from the group consisting of a  
15 fluorescent label, a radioactive label, a nuclear magnetic resonance active label, a luminescent label, and a chromophore label.

34. A method according to claim 21, wherein  
20 the biological agent is in a composition further comprising a physiologically acceptable carrier, excipient, or stabilizer.

35. A method according to claim 21, wherein  
25 the biological agent is in a composition further comprising a pharmaceutically acceptable carrier, excipient, or stabilizer.

36. A method according to claim 21, wherein  
30 said contacting is carried out in a sample of serum or urine.

37. A method according to claim 21, wherein  
said contacting is carried out in a tissue biopsy sample.

35

- 68 -

38. A method of ablating or killing normal, benign hyperplastic, and cancerous prostate epithelial cells comprising:

5 providing a biological agent which binds to an extracellular domain of prostate specific membrane antigen and

10 contacting said cells with the biological agent under conditions effective to permit both binding of the biological agent to the extracellular domain of the prostate specific membrane antigen and ablating or killing of said cells.

15 39. A method according to claim 38, wherein the biological agent is an antibody or binding portion thereof, probe, or ligand.

20 40. A method according to claim 38, wherein the biological agent is internalized with the prostate specific membrane antigen.

41. A method according to claim 38, wherein said contacting is carried out in a living mammal and comprises:

25 administering the biological agent to the mammal under conditions effective to permit both binding of the biological agent to the extracellular domain of the prostate specific membrane antigen and killing of said cells.

30 42. A method according to claim 41, wherein the biological agent is internalized with the prostate specific membrane antigen.

35 43. A method according to claim 41, wherein said administering is carried out orally, parenterally, subcutaneously, intravenously, intramuscularly, intraperitoneally, by intranasal instillation, by

- 69 -

intracavitary or intravesical instillation, intraocularly, intraarterially, intralesionally, or by application to mucous membranes.

5           44. A method according to claim 39, wherein an antibody is used in carrying out said method, the antibody being selected from the group consisting of a monoclonal antibody and a polyclonal antibody.

10           45. A method according to claim 44, wherein the antibody is selected from the group consisting of an E99, a J415, a J533, and a J591 monoclonal antibody.

15           46. A method according to claim 44, wherein the antibody is a monoclonal antibody produced by a hybridoma cell line having an ATCC Accession Number selected from the group consisting of HB-12101, HB-12109, HB-12127, and HB-12126.

20           47. A method according to claim 39, wherein a binding portion of an antibody is used in carrying out said method, the binding portion being selected from the group consisting of an Fab fragment, an F(ab')<sub>2</sub> fragment, and an Fv fragment.

25           48. A method according to claim 39, wherein the probe or ligand is used in carrying out said method.

30           49. A method according to claim 38, wherein the biological agent is bound to a substance effective to kill or ablate said cells upon binding of the biological agent to the extracellular domain of the prostate specific membrane antigen of said cells.

35           50. A method according to claim 49, wherein the substance effective to kill said cells is a cytotoxic drug.

- 70 -

51. A method according to claim 50, wherein  
the cytotoxic drug is selected from the group consisting  
of therapeutic drug, a compound emitting radiation,  
5 molecules of plant, fungal, or bacterial origin,  
biological proteins, and mixtures thereof.

52. A method according to claim 39, wherein  
the antibody is effective to initiate an endogenous host  
10 immune function.

53. A method according to claim 52, wherein  
the endogenous host immune function is complement-  
mediated cellular cytotoxicity.

15

54. A method according to claim 52, wherein  
the endogenous host immune function is antibody-dependent  
cellular cytotoxicity.

20 55. A method according to claim 38, wherein  
the biological agent is in a composition further  
comprising a physiologically acceptable carrier,  
excipient, or stabilizer.

25 56. A method according to claim 38, wherein  
the biological agent is in a composition further  
comprising a pharmaceutically acceptable carrier,  
excipient, or stabilizer.

30 57. A method according to claim 38 further  
comprising:

providing a second biological agent which binds  
to the extracellular domain of prostate specific membrane  
antigen and

35 contacting said cells with the second  
biological agent under conditions effective to permit  
binding of the second biological agent to the



- 71 -

extracellular domain of the prostate specific membrane antigen.

58. A method according to claim 57, wherein  
5 the biological agent and the second biological agent bind to non-competing binding sites on the extracellular domain of the prostate specific membrane antigen.

59. A method according to claim 57, wherein  
10 the biological agent is a J415 monoclonal antibody and the second biological agent is an E99, a J533, or a J591 monoclonal antibody.

60. A method according to claim 57, wherein  
15 the biological agent is bound to a substance effective to kill or ablate said cells upon binding of the biological agent to the extracellular domain of the prostate specific membrane antigen of said cells and upon activation by an activator and wherein the second  
20 biological agent is bound to the activator.

61. A method of detecting normal, benign hyperplastic, and cancerous prostate epithelial cells or a portion thereof in a biological sample comprising:  
25 providing an biological agent which binds to an extracellular domain of prostate specific membrane antigen, wherein the biological agent is bound to a label effective to permit detection of said cells or a portion thereof upon binding of the biological agent to said  
30 cells or a portion thereof;

contacting the biological sample with the biological agent having a label under conditions effective to permit binding of the biological agent to the extracellular domain of the prostate specific  
35 membrane antigen of any of said cells or a portion thereof in the biological sample; and

- 72 -

detecting a presence of any of said cells or a portion thereof in the biological sample by detecting the label.

5                   62. A method according to claim 61, wherein the biological agent is an antibody or binding portion thereof, probe, or ligand.

10                   63. A method according to claim 61, wherein the biological agent is internalized with the prostate specific membrane antigen.

15                   64. A method according to claim 61, wherein said contacting is carried out in a living mammal and comprises:

administering the biological agent to the mammal under conditions effective to permit binding of the biological agent to the extracellular domain of the prostate specific membrane antigen of any of said cells  
20 or a portion thereof in the biological sample.

65. A method according to claim 64, wherein the label is a short-range radiation emitter.

25                   66. A method according to claim 64, wherein said detecting is carried out rectally.

30                   67. A method according to claim 64, wherein the biological sample is the mammal's prostatic fossa.

68. A method according to claim 64, wherein said detecting is carried out after a prostatectomy.

35                   69. A method according to claim 64, wherein the biological agent is internalized with the prostate specific membrane antigen.

- 73 -

70. A method according to claim 64, wherein said administering is carried out orally, parenterally, subcutaneously, intravenously, intramuscularly, intraperitoneally, by intraversal instillation, by  
5 intracavitary or intravesical instillation, intraocularly, intraarterially, intralesionally, or by application to mucous membranes.

71. A method according to claim 62, wherein an  
10 antibody is used in carrying out said method, said antibody being selected from the group consisting of a monoclonal antibody and a polyclonal antibody.

72. A method according to claim 71, wherein  
15 the antibody is selected from the group consisting of an E99, a J415, a J533, and a J591 monoclonal antibody.

73. A method according to claim 71, wherein the antibody is a monoclonal antibody produced by a  
20 hybridoma cell line having an ATCC Accession Number selected from the group consisting of HB-12101, HB-12109, HB-12127, and HB-12126.

74. A method according to claim 62, wherein a  
25 binding portion of an antibody is used in carrying out said method, the binding portion being selected from the group consisting of an Fab fragment, an F(ab')<sub>2</sub> fragment, and an Fv fragment.

30 75. A method according to claim 62, wherein a probe or ligand is used in carrying out said method.

76. A method according to claim 61, wherein the label is selected from the group consisting of a  
35 fluorescent label, a radioactive label, a nuclear magnetic resonance active label, a luminescent label, and a chromophore label.

- 74 -

77. A method according to claim 61, wherein the biological agent is in a composition further comprising a physiologically acceptable carrier, excipient, or stabilizer.

5

78. A method according to claim 61, wherein the biological agent is in a composition further comprising a pharmaceutically acceptable carrier, excipient, or stabilizer.

10

79. A method according to claim 61, wherein said contacting is carried out in a sample of serum or urine.

15

80. An isolated biological agent which binds to an extracellular domain of prostate specific membrane antigen.

20

81. An isolated biological agent according to claim 80, wherein said isolated biological agent is an isolated antibody or binding portion thereof, probe, or ligand.

25

82. An isolated biological agent according to claim 80, wherein the biological agent is internalized with the prostate specific membrane antigen.

30

83. An isolated biological agent according to claim 81, wherein the isolated biological agent is an antibody selected from the group consisting of a monoclonal antibody and a polyclonal antibody.

35

84. An isolated biological agent according to claim 83, wherein the antibody is selected from the group consisting of an E99, a J415, a J533, and a J591 monoclonal antibody.

- 75 -

85. An isolated biological agent according to claim 83, wherein the antibody is a monoclonal antibody produced by a hybridoma having an ATCC Accession Number selected from the group consisting of HB-12101, HB-12109, HB-12127, and HB-12126.

86. An isolated biological agent according to claim 81, wherein the isolated biological agent is a binding portion of an antibody selected from the group consisting of a Fab fragment, a F(ab')<sub>2</sub> fragment, and a Fv fragment.

87. An isolated biological agent according to claim 81, wherein the isolated biological agent is a probe or ligand.

88. An isolated biological agent according to claim 80, wherein the biological agent is bound to a cytotoxic drug.

89. An isolated biological agent according to claim 88, wherein the cytotoxic drug is selected from the group consisting of a therapeutic drug, a compound emitting radiation, molecules of plant, fungal, or bacterial origin, biological proteins, and mixtures thereof.

90. A composition comprising:  
a biological agent according to claim 88 and  
a physiologically acceptable carrier,  
excipient, or stabilizer mixed with the biological agent.

91. A composition comprising:  
a biological agent according to claim 88 and  
a pharmaceutically acceptable carrier,  
excipient, or stabilizer mixed with the biological agent.

- 76 -

92. An isolated biological agent according to claim 80, wherein said biological agent is bound to a label.

5           93. An isolated biological agent according to claim 92, wherein the label is selected from the group consisting of a fluorescent label, a biologically-active enzyme label, a radioactive label, a nuclear magnetic resonance active label, a luminescent label, and a  
10 chromophore label.

          94. A composition comprising:  
a biological agent according to claim 92 and  
a physiologically acceptable carrier,  
15 excipient, or stabilizer mixed with the biological agent.

          95. A composition comprising:  
a biological agent according to claim 92 and  
20 a pharmaceutically acceptable carrier,  
excipient, or stabilizer mixed with the biological agent.

          96. A kit for detecting cancer comprising:  
a biological agent according to claim 92 and  
25 means to detect the label.

          97. A kit according to claim 96, wherein the label is selected from the group consisting of a fluorescent label, a biologically-active enzyme label, a  
30 radioactive label, a nuclear magnetic resonance active label, a luminescent label, and a chromophore label.

          98. A kit according to claim 96, wherein said biological agent is an E99, a J415, a J533, or a J591  
35 monoclonal antibody.

- 77 -

99. A kit according to claim 96, wherein the biological agent is in a composition further comprising a physiologically acceptable carrier, excipient, or stabilizer.

5

100. A kit according to claim 96, wherein the biological agent is in a composition further comprising a pharmaceutically acceptable carrier, excipient, or stabilizer.

10

101. A kit according to claim 96, wherein the cancer is selected from the group consisting of prostate cancer, renal cancer, urothelial cancer, colon cancer, lung cancer, breast cancer, and metastatic adenocarcinoma to the liver

15

102. A hybridoma cell line that produces a monoclonal antibody which binds to an extracellular domain of prostate specific membrane antigen.

20

103. A hybridoma cell according to claim 102, wherein the antibody is internalized with the prostate specific membrane antigen.

25

104. A hybridoma cell line according to claim 102, wherein the monoclonal antibody is an E99, a J415, a J533, or a J591 monoclonal antibody.

30

105. A hybridoma cell line according to claim 102 wherein the hybridoma cell line has an ATCC Accession Number selected from the group consisting of HB-12101, HB-12109, HB-12127, and HB-12126.

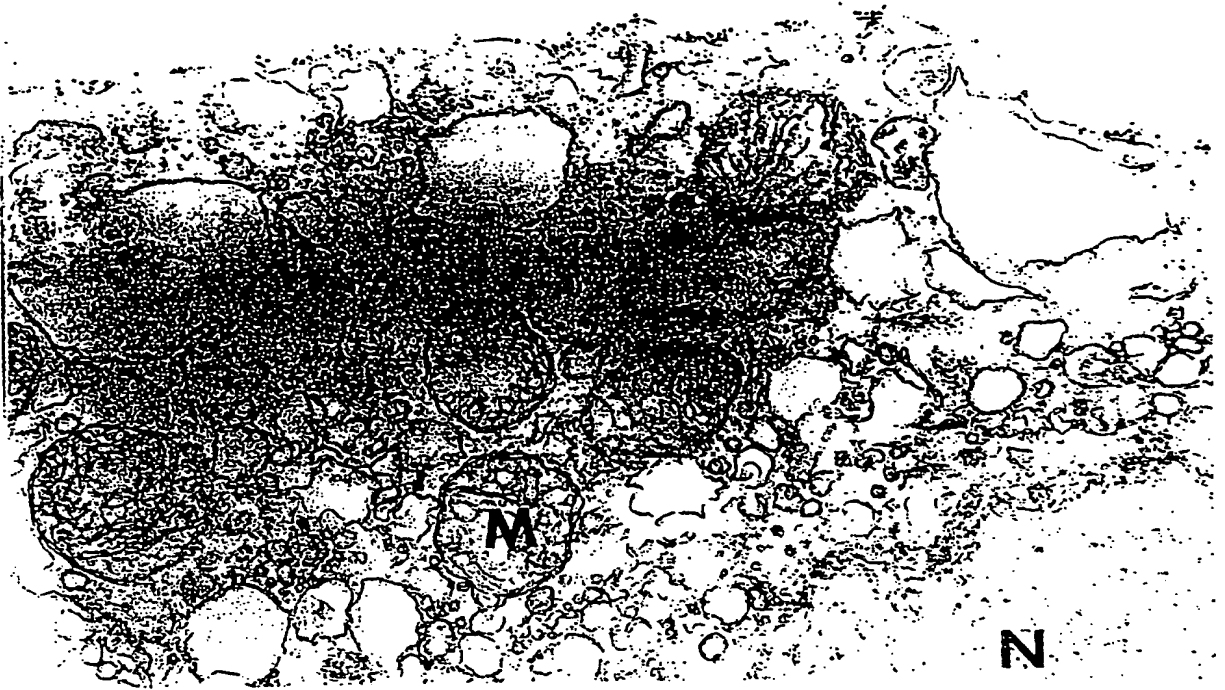


FIGURE 1



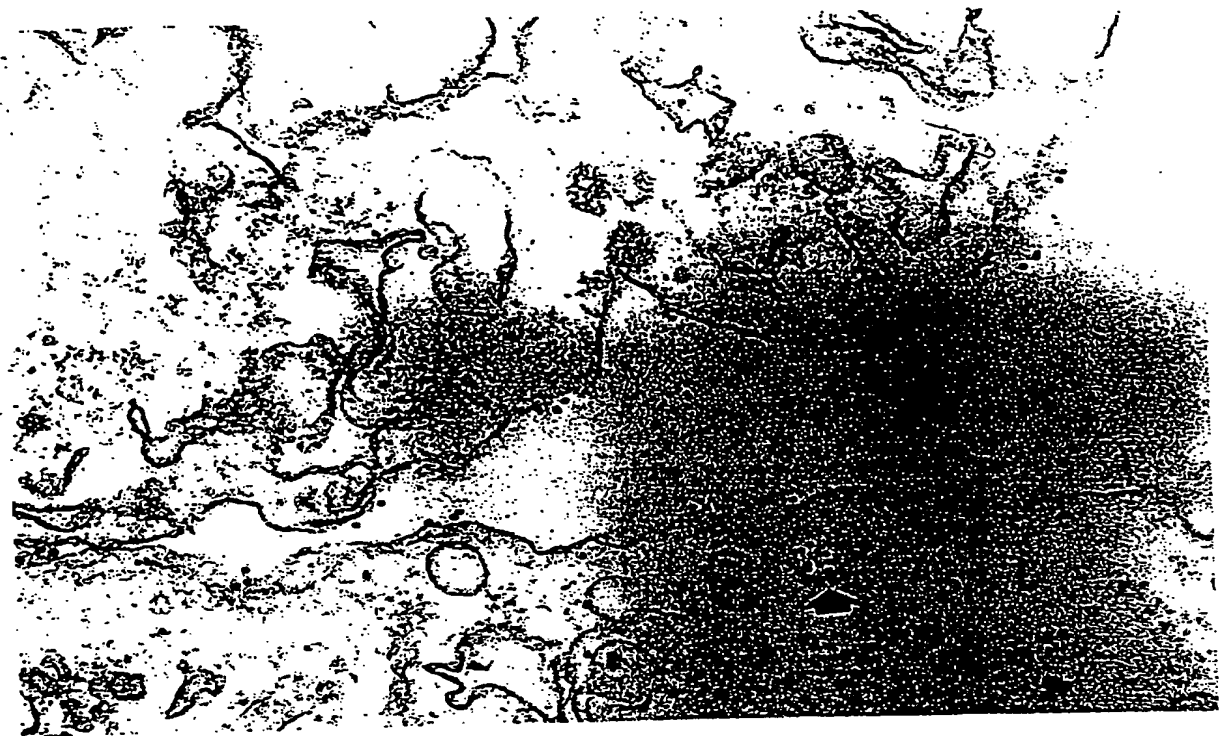


FIGURE 2

3/12



FIGURE 3

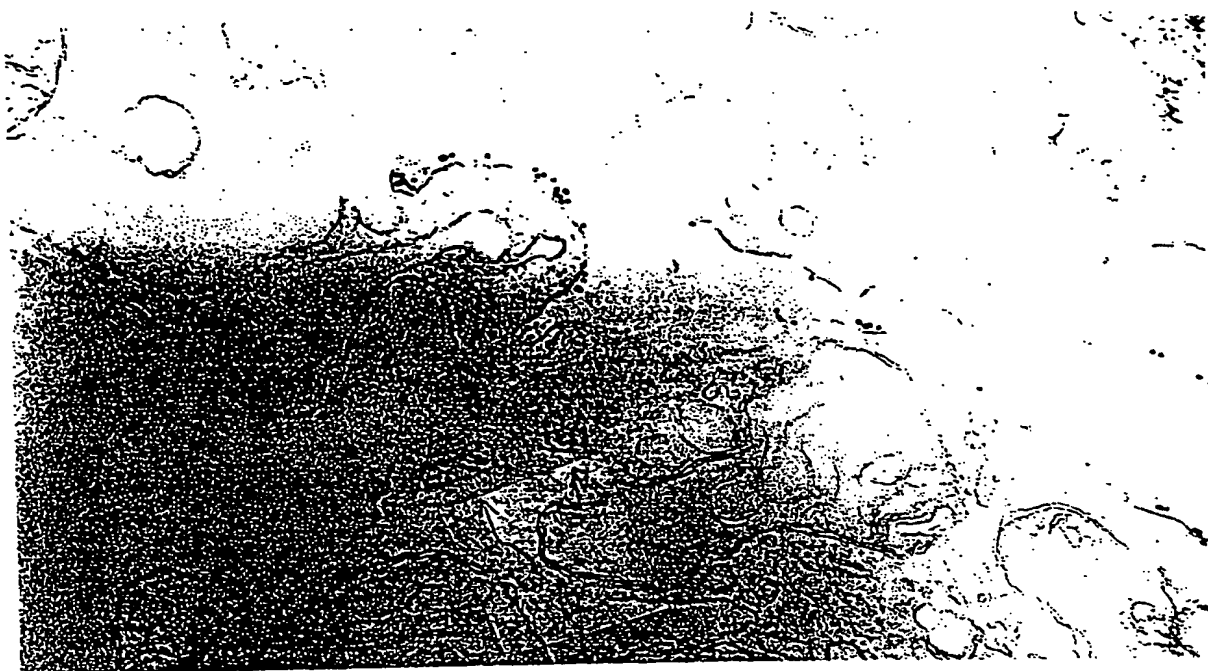


FIGURE 4



FIGURE 5

6/12

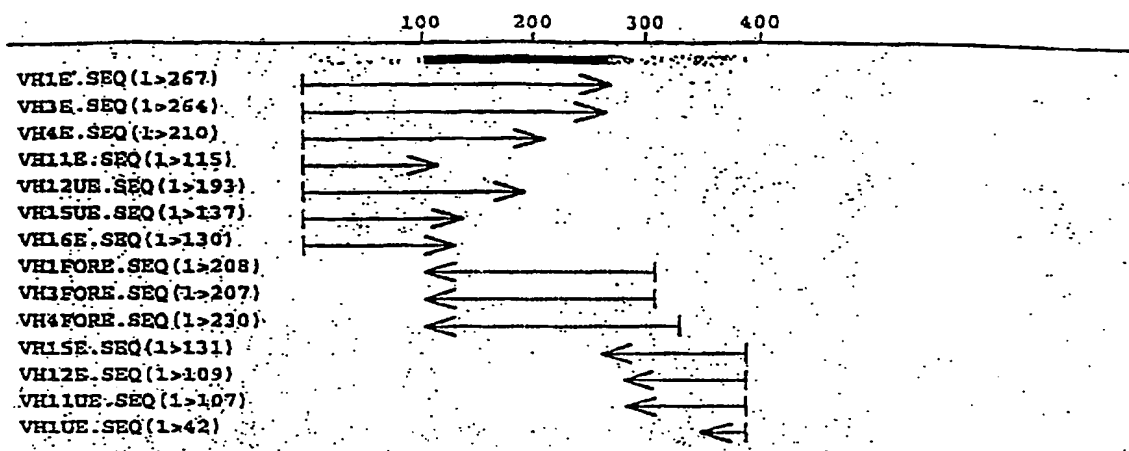


FIGURE 6

Enzymes : All 74 enzymes (No Filter).	
Settings: Linear, Certain Sites Only, Standard Genetic Code	
SEQ. ID. NO. 1	TCTCCTGTCAGGAAGTCAGGTGTCTCTCTGAGGTCCAGCTGCAACAGTCTGGACCTGAACTGGTGAAG
SEQ. ID. NO. 2	AGAGGACAGTCTCTGACGTCCACAGGAGAGACTCCAGGTGACGTTGTCAGACCTGGACTTGACCACTTC
SEQ. ID. NO. 3	S P V R N C R C P L . G P A A T V W T . T G E
SEQ. ID. NO. 4	L L S G T A G V L S E Y Q L O O S G P E L V K
SEQ. ID. NO. 5	L S C O E L Q V S S L R S S C N S L D L N W . S
SEQ. ID. NO. 1	CCTGGGACTTCAGTGAGGATATCCTGCAAGACTCTGGATACACATTCACTGAATATACCATACACTGGG
SEQ. ID. NO. 2	GGACCTGAAGTCACTCCTATAGGACGTTCTGAAGACCTATGTGTAAGTGACTTATATGGTATGTGACCC
SEQ. ID. NO. 3	A W D F S E D I L Q O F V I H I H . I Y H T L G
SEQ. ID. NO. 4	P G T S V R I S C K T S G Y T F T E Y T I H V
SEQ. ID. NO. 5	L G L Q . G Y P A R L L D T H S L N I P Y T G
SEQ. ID. NO. 1	TGAAGCAGAGCCATCGAAAGAGCCTTGAGTGGATTGGAAACATCAATCCTAACAATGGTGGTACCACCTA
SEQ. ID. NO. 2	ACTTCGTCTCGGTACCTTTCTCGGAAGTCACCTAACCTTTGTAGTTAGGATTGTTACCACCATGGTGGAT
SEQ. ID. NO. 3	E A E P W K E P . V D W K H O S . Q W W Y H L
SEQ. ID. NO. 4	V K O S H G K S L E W I G N I N P N N G G T T Y
SEQ. ID. NO. 5	S R A H E R A L S G L E T S I L T H V V P P
SEQ. ID. NO. 1	CAATCAGAAGTTCGAGGACAAGGCCACATTGACTGTAGACAAGTCTCCAGTACAGCCTACATGGAGCTC
SEQ. ID. NO. 2	GTTAGTCTTCAAGCTCCTGTTCCGGTGTAAGTACATCTGTTGAGGAGGTGATGTCGGATGTACCTCGAG
SEQ. ID. NO. 3	O S E V R G O G H I D C R O V L O Y S L H G A
SEQ. ID. NO. 4	N O K F E D K A T L T V O K S S S T A Y H E L
SEQ. ID. NO. 5	T I R S S R T R P H . L . T S P P V Q P T W S S
SEQ. ID. NO. 1	CGCAGCCTAACATCTGAGGATTCTGCAGTCTATTATTGTGCAGCTGGTTGGAACCTTTGACTAGTGGGGCC
SEQ. ID. NO. 2	GGTCCGATTGTAGACTCCTAAGACGTACAGATAATAACAGTCGACCAACCTTGAAACTGATGACCCCGG
SEQ. ID. NO. 3	P O P N I . G F C S L L L C S W L E L . L L G P
SEQ. ID. NO. 4	R S L T S E D S A V Y Y C A A G W N F D Y W G
SEQ. ID. NO. 5	A A . H L R I L O S I I V O L V G T L T T G A
SEQ. ID. NO. 1	AAGGCACCACTCTCAGACTCTCTCAGCCAAAACGACACCC
SEQ. ID. NO. 2	TTCCGTGGTGAGAGTGTGAGAGGAGTCGCTTTTGTCTGTGGG
SEQ. ID. NO. 3	R H H S H S L L S O N D T
SEQ. ID. NO. 4	O G T T L T V S S A K T T P
SEQ. ID. NO. 5	K A P L S O S P O P K R H P

FIGURE 7

8/12

## Lipman-Pearson Protein Alignment

Ktuple: 2; Gap Penalty: 4; Gap.Length Penalty: 12

Seq1(1>115)	Seq2(1>125)	Similarity Index	Gap Number	Gap Length	Consensus Length
J591VH.PRO	MUVHIA.PRO	75.6	2	10	125
(1>115)	(1>125)				

```

      10      20      30      40      50
EVQLQDSGP10ELVKPG20TSVRISCKTSGYTFIEYTI-HWVKQSHGKSLEWIGNINPNNGGTT
EVQLQDSGP10ELVKPG:SV:ISCK:SGYTFT:Y: :WVKQS.GKSLEWIG:INP.NGGT:
EVQLQDSGP10ELVKPGASVKISCKASGYTFTDYYMNNWVKOSPGKSLEWIGDINPGNGGTS-
      60      70      80      90      100      110
YNOKFEDKATLTVDKSSSTAYMELRSLTSEDSAVYYCAAG-----WNFDYWGQGT
YNOKF:KATLTVDKSSSTAYM:L.SLTSEDSAVYYCA.G...FDYWGQGT
YNOKFKGKATLTVDKSSSTAYMQLSSLTSEDSAVYYCARGYSSSYMAYYAFDYWGQGT
      70      80      90      100      110      120

```

LTVSS  
:TVSS  
VTVSS

FIGURE 8

9/12

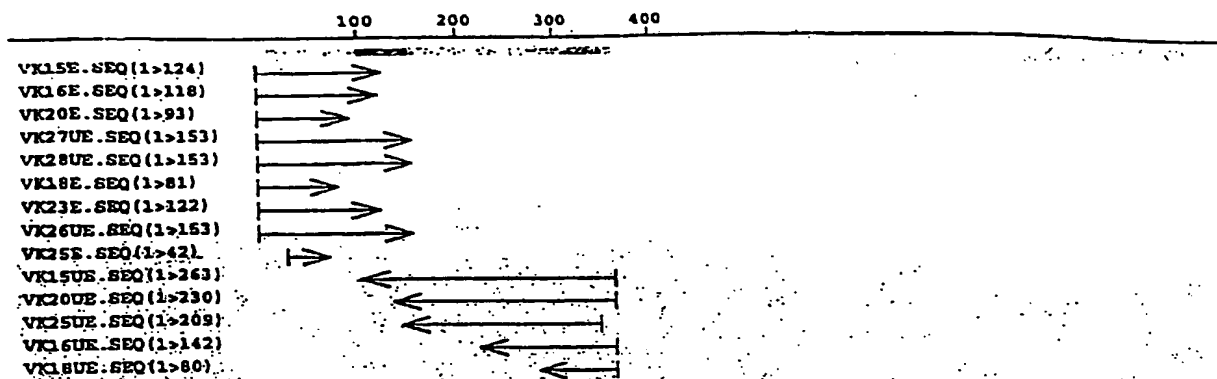


FIGURE 9



Enzymes: All 74 enzymes (No Filter)  
 Settings: Linear, Certain Sites Only, Standard Genetic Code

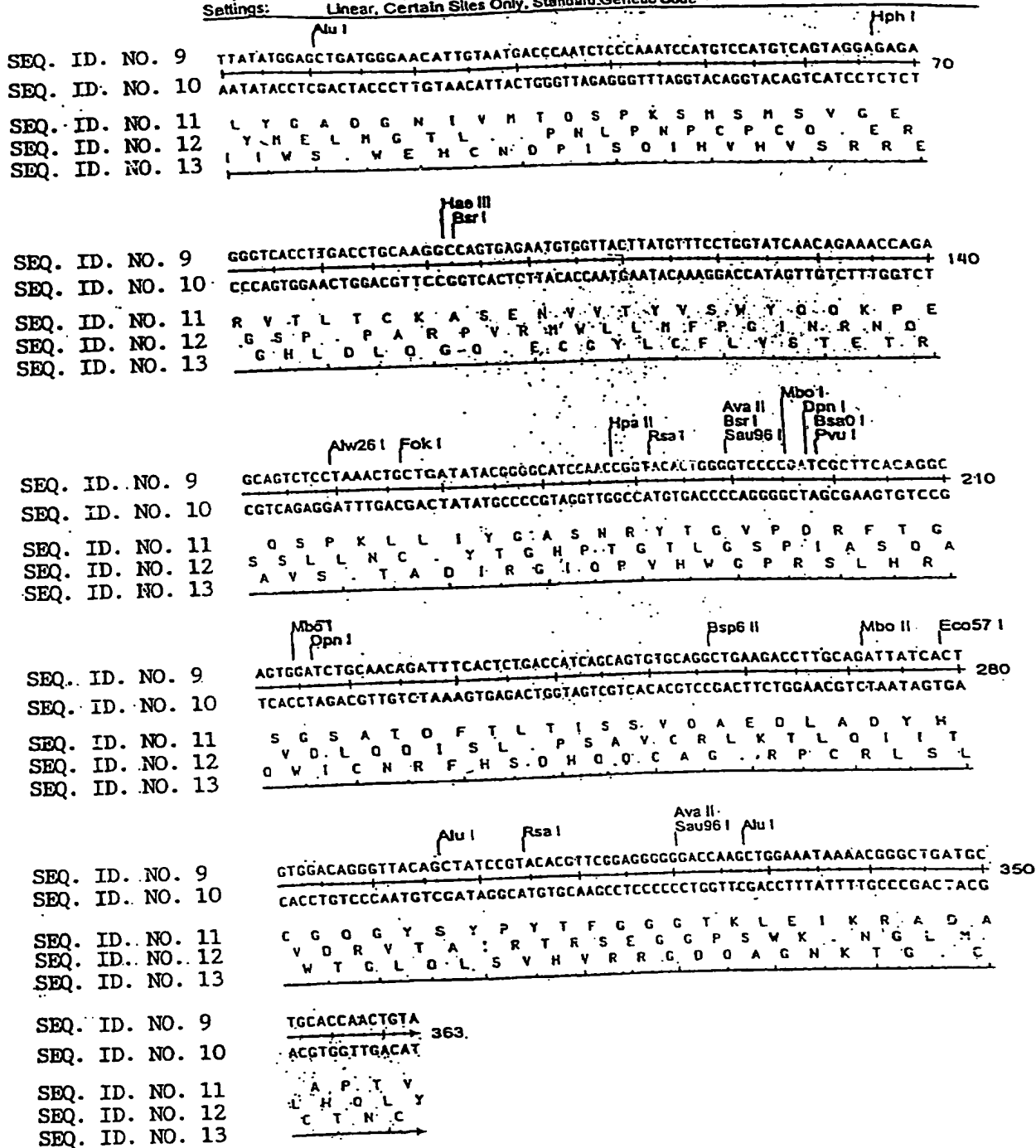


FIGURE 10

11/12

## Lipman-Pearson Protein Alignment

Ktuple: 2; Gap Penalty: 4; Gap Length Penalty: 12

Seq1(1>107)	Seq2(1>111)	Similarity Index	Gap Number	Gap Length	Consensus Length
J591VK.PRO	MUVKV.PRO	60.4	2	2	109
(1>107)	(1>109)				
10 20 30 40 50 60 70 80 90 100	10 20 30 40 50 60 70 80 90 100				
NIVMTQSPKSMMSVGERVTLTCKAS-ENVVTYVSWYQOKPEQSPKLLIYGASNRYTGVP					
I MTQSP.S:S S:G:RVT:TC:AS : : : Y::WYQOKP. SPKLLIY AS: :GVP					
DIOMTQSPSSLSASLGDRVTITCRASODDISNYLNWYQOKPGGSPKLLIYYASRLHSGVP					
DRFJGSGSATDFTLTSSVOAEDLADYHCGOGYSY-PYTFGGGKLEIK					
RE:GSGS:TD:LT:IS:::ED:A:Y C:QG::P TFGGKLEIK					
SRFSGSGSGTDYSLTISNLEQEDTATYFCQOGNTLPRTFGGKLEIK					

FIGURE 11



FIGURE 12

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US97/12035

<b>A. CLASSIFICATION OF SUBJECT MATTER</b> IPC(6) : G01N 33/574, 33/53, 33/569, 33/48 US CL : 435/7.2, 7.23; 436/63, 64 According to International Patent Classification (IPC) or to both national classification and IPC																				
<b>B. FIELDS SEARCHED</b> Minimum documentation searched (classification system followed by classification symbols) U.S. : 435/7.2, 7.23; 436/63, 64  Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched  Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) DIALOG, APS																				
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>																				
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.																		
Y	WRIGHT, G. L. Expression of Prostate-Specific Membrane Antigen in Normal, Benign, and Malignant Prostate Tissues, Urologic Oncology. 1995. Vol. 1. No. 1. pages 18-28, especially page 18.	1-105																		
Y	MURPHY, G.P. Measurement of Prostate-Specific Membrane Antigen in the Serum with a New Antibody; The Prostate. April 1996. Vol. 28. No. 4. pages 266-271, especially page 266.	1-105																		
Y	ISRAELI, R.S. Molecular Cloning of a Complementary DNA Encoding a Prostate-specific Membrane Antigen; January 1993. Vol. 53. No. 2. pages 227-230, especially page 227.	1-105																		
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.																				
<table border="0"><tr><td>* Special categories of cited documents:</td><td>*T</td><td>later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</td></tr><tr><td>*A* document defining the general state of the art which is not considered to be of particular relevance</td><td>*X</td><td>document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</td></tr><tr><td>*B* earlier document published on or after the international filing date</td><td>*Y*</td><td>document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</td></tr><tr><td>*L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</td><td>*A*</td><td>document member of the same patent family</td></tr><tr><td>*O* document referring to an oral disclosure, use, exhibition or other means</td><td></td><td></td></tr><tr><td>*P* document published prior to the international filing date but later than the priority date claimed</td><td></td><td></td></tr></table>			* Special categories of cited documents:	*T	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention	*A* document defining the general state of the art which is not considered to be of particular relevance	*X	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone	*B* earlier document published on or after the international filing date	*Y*	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art	*L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	*A*	document member of the same patent family	*O* document referring to an oral disclosure, use, exhibition or other means			*P* document published prior to the international filing date but later than the priority date claimed		
* Special categories of cited documents:	*T	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention																		
*A* document defining the general state of the art which is not considered to be of particular relevance	*X	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone																		
*B* earlier document published on or after the international filing date	*Y*	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art																		
*L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	*A*	document member of the same patent family																		
*O* document referring to an oral disclosure, use, exhibition or other means																				
*P* document published prior to the international filing date but later than the priority date claimed																				
Date of the actual completion of the international search 28 SEPTEMBER 1997		Date of mailing of the international search report 17 NOV 1997																		
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230		Authorized officer YVONNE EYLER Telephone No. (703) 308-0196																		

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US97/12035

## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	ISRAELI, R.S. "Expression of the Prostate-specific Membrane Antigen" Cancer Research. April 1994. Vol. 54. No. 7. pages 1807-1811, especially page 1807.	1-105
Y	US 5,489,525 A (PASTAN) 06 FEBUARY 1996, col. 2, lines 21-51.	1-105

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US97/12035

## Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
  
2. ☐ Claims Nos.:  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
  
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Please See Extra Sheet.

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
  
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.  
☐ No protest accompanied the payment of additional search fees.

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US97/12035

### BOX II. OBSERVATIONS WHERE UNITY OF INVENTION WAS LACKING

This ISA found multiple inventions as follows:

This application contains the following inventions or groups of inventions which are not so linked as to form a single inventive concept under PCT Rule 13.1. In order for all inventions to be searched, the appropriate additional search fees must be paid.

Group I, claim(s) 1-20, 38-60 and 80-105, drawn to antibodies to prostate membrane antigen and a method of using them to treat cancer.

Group II, claim(s) 21-37 and 61-79, drawn to a second method of using antibodies to detect prostate membrane antigen.

The inventions listed as Groups I and II do not relate to a single inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: The methods of use of Groups I and II are entirely different methods with different outcomes. A method of detection does not actively treat a cancer.

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US97/12035

### BOX II. OBSERVATIONS WHERE UNITY OF INVENTION WAS LACKING

This ISA found multiple inventions as follows:

This application contains the following inventions or groups of inventions which are not so linked as to form a single inventive concept under PCT Rule 13.1. In order for all inventions to be searched, the appropriate additional search fees must be paid.

Group I, claim(s) 1-20, 38-60 and 80-105, drawn to antibodies to prostate membrane antigen and a method of using them to treat cancer.

Group II, claim(s) 21-37 and 61-79, drawn to a second method of using antibodies to detect prostate membrane antigen.

The inventions listed as Groups I and II do not relate to a single inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: The methods of use of Groups I and II are entirely different methods with different outcomes. A method of detection does not actively treat a cancer.



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